

# THE AMERICAN MINERALOGIST

JOURNAL OF THE MINERALOGICAL SOCIETY OF AMERICA

Vol. 25

MARCH, 1940

No. 3

## THE PROBLEM OF THE CARBONATE-APATITES. III. CARBONATE-APATITE FROM MAGNET COVE, ARKANSAS

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### INTRODUCTION

The problem of the carbonate-apatites is an interesting one from the standpoint of the mineralogist, to be sure, but it is also of interest to the biological chemist because of its bearing upon the composition of teeth and bones. Indeed, biological chemists have contributed considerable experimental data and have displayed such a lively interest in this problem that their viewpoint cannot be neglected even in an investigation which is purely mineralogical. Since the appearance of the first paper by the writers (1) it has become evident that doubt still exists among certain investigators as to the homogeneity of the materials investigated.

J. Thewlis, G. E. Glock and M. M. Murray (2) do not raise for the first time the question of the existence of carbonate-apatites, nor is it probable that F. Machatschki (3) raises the question for the last time. However, it is becoming increasingly more difficult to question the existence of carbonate-apatites without completely ignoring considerable evidence which indicates the existence of these rather peculiar compounds. The fact that carbonate-apatites have been described by numerous well-known mineralogists is in itself some recommendation for their existence, but nevertheless, it is well to consider the matter without prejudice and examine the evidence.

This can be done without consideration of the structural hypothesis which the writers (1) have postulated for carbonate-apatites, because the success or failure which attends the establishment of an hypothesis to account for a physical entity cannot be considered as evidence in direct proof or disproof of the entity. Certain objections to the hypothesis, which was presented to account for the occurrence of carbon in the apatite lattice, have appeared, and these will be answered in terms of the data which were presented in opposition, as well as additional data.

Thewlis, Glock and Murray (2) have objected to the evidence presented to establish the existence of carbonate-apatites, and present certain data to justify their contention that carbonate-apatites are non-existent. This was accomplished chiefly in terms of a number of analytical results. However, these results were not only unconvincing in themselves but were used in conjunction with an error in deduction which was presented as a corollary to the hypothesis presented by the writers. I. D. Borneman-Starinkevitch (4) raises a question regarding the manner of displacement of calcium and the placement of carbon in the structure, as suggested by us (1 and 5), but accepts the substitution of carbon for phosphorus (6). N. V. Belov (7) presented a modified hypothesis for the introduction of carbon which would not require the assumption of  $\text{CO}_4$  groups, but one of us (8) has shown that Belov's modified hypothesis is not in accord with the experimental data which are available to test it, although these data are quite consistent with the original hypothesis. F. Machatschki's opinion (3) is stated very briefly, but it is essentially similar to that of Thewlis, Glock and Murray, in that he believes carbonate-apatites are to be accounted for in terms of contamination—crystalline  $\text{CaCO}_3$  being contained between the fine fibers of the apatite.

It has never been demonstrated in any of these studies that such relatively pure and homogeneous substances as the carbonate-apatite from Staffell, Nassau, will produce diffraction lines of calcite or aragonite, in spite of the fact that this material yields sufficient  $\text{CO}_2$  on analysis to require more than seven per cent of  $\text{CaCO}_3$ , if the  $\text{CO}_2$  were present as simple carbonate. This is likewise true of francolite from Devon (9), and of dahllite from Mouillac, France (6), except that the  $\text{CO}_2$  obtained in the latter case would require about ten per cent of  $\text{CaCO}_3$ . However, it has been stated (2) that it is not possible to detect less than ten per cent of  $\text{CaCO}_3$  when mechanically mixed with hydroxy-apatite, and this negative evidence has been emphasized in support of the contention that carbonate-apatites are non-existent.

#### X-RAY DATA

Thewlis, Glock and Murray were cognizant of the fact that H. H. Roseberry, A. B. Hastings and J. K. Morse (10) failed to find any evidence of the presence of  $\text{CaHPO}_4$  or  $\text{CaCO}_3$  in tooth substance, but they do not mention that M. A. Bredig, H. H. Franck and H. Földner (11) claim to have prepared synthetic carbonate hydroxy-apatites and recognized small but distinct differences on comparing the patterns produced by these with diffraction patterns of hydroxy-apatite and fluor-apatite. Thewlis, Glock and Murray indicate that P. Niggli and E. Branden-



berger (2) "... found that less than 10 per cent of  $\text{CaCO}_3$  cannot be detected when mixed with hydroxy-apatite. . . ." The original work states: "Bei der Mischung Knochenasche: Calcit = 10:1 sind selbständige Calcitinterferenzen eben noch erkennbar neben einzelnen charakteristischen Intensitätsverschiebungen bei den Linien des Hydroxylapatits." And further on "Kleinere Calcitgehalte dürften sich auf diesem Wege *nicht mit der wünschbaren Sicherheit* nachweisen lassen."

The writers prepared a number of powder diffraction diagrams using unfiltered Fe radiation and precision cameras of 57.3 mm. radius. Diffraction diagrams which were compared with one another were obtained in the same camera and considerable care was given to preparation of samples in order to have their dimensions uniform.

It is not difficult to distinguish two lines of calcite (including the most intense line,  $d = 3.029 \text{ \AA}$ ) when five per cent of calcite is mixed with francolite [staffelite]. Aragonite also can be detected when present in quantities as little as five per cent. These statements were also found to be true when an analyzed sample of fluor-apatite was employed.

Greater difficulty is experienced in detecting the presence of calcite in non-mineral hydroxy-apatites, not on account of coincidence of the calcite and phosphate lines, but due to failure of the phosphate to produce patterns with sufficient sharpness of resolution. Were it possible to obtain a synthetic hydroxy-apatite, capable of producing lines as distinct as those obtained with minerals, it would probably not be any more difficult to detect five per cent of calcite or aragonite in hydroxy-apatite than it is in francolite or fluor-apatite. The difficulties associated with the detection of calcite or aragonite when mixed with dentine or enamel are likewise associated with the broad and diffuse lines which these substances produce.

An attempt was made to obtain hydroxy-apatite with coarser granularity by heating the phosphate in 0.5 N solution of KOH in a gold-lined bomb at  $300^\circ \text{C}$ . for ten days. (Bomb capacity 50 cc., phosphate sample 1 g., 25 cc. KOH soln.) However, this treatment failed to increase noticeably the sharpness of the diffraction diagram, and the line  $d = 3.029 \text{ \AA}$  of calcite was just visible in a sample mixed with five per cent of calcite, and even then only detectable on comparison with a pattern prepared from the phosphate alone. The slight intensity differences which arise are not sufficiently pronounced to be diagnostic.

It has been the contention of those who believe that the  $\text{CaCO}_3$  is present as contamination that the individual crystals of  $\text{CaCO}_3$  are submicroscopic—presumably so small as to produce very diffuse diffraction lines which cannot be detected among the diffraction lines of the

phosphate. However, it seems hardly probable that as much as 10 per cent of  $\text{CaCO}_3$  could be present without being capable of detection by microscopic or x-ray methods or both. This is particularly true in view of the fact that  $\text{CaCO}_3$  usually occurs as one of two distinctly crystalline forms, calcite or aragonite. It is noteworthy that no direct proof of the existence of these submicroscopic or "colloidal" particles of  $\text{CaCO}_3$  in apatite has ever been presented, and the principal arguments used in support of the existence of these particles are based upon the analytical results which are discussed below.

#### CHEMICAL DATA

If submicroscopic particles of  $\text{CaCO}_3$  were to occur in apatites, they might be expected to occur in the complex textures of teeth and bones. Even here, however, the structural and chemical similarities (13) between these complex substances of organic origin and crystalline carbonate-apatites are such as to indicate that this supposition is highly improbable. R. Klement (14) has recently discussed the chemical relations and concludes that the writers' hypothesis accounts for the analytical results in a most satisfactory manner.

Thewlis, Glock and Murray reach certain conclusions regarding the correlation of Ca/P ratios with the  $\text{CO}_2$  content, and this represents a major portion of the data which were presented. Although it is frequently true, as they have indicated, that more C replaces P than replaces Ca and this would cause an increase in Ca/P, this is not necessarily always true as the ratio (C replacing P)/(C replacing Ca) is dependent upon the ratio  $(\text{F} + \text{OH} + \text{Cl})/\text{O}$ , because electrostatic neutrality must obtain. The theoretical value of the latter ratio is 1/12 for fluorapatite but decreases in oxy-apatite (6) and increases as the sum of the atomic amount of  $(\text{F} + \text{OH} + \text{Cl})$  becomes greater than two, as it does in francolite (3). A more detailed consideration of Ca/P ratios has recently been presented by one of us (8).

Thewlis, Glock and Murray determined P by a colorimetric method involving aminonaphtholsulfonic acid, which C. H. Fiske and Y. Subbarow (15) devised for determination of very small amounts of P, and this was done apparently without any attempt to demonstrate that the colorimetric method was suitable to determinations involving large amounts of P. They have attempted to use the theoretical value  $\text{Ca}/\text{P} = 2.15^*$  (ratio of weights) [ $\text{Ca}/\text{P} = 1.667$  (atomic ratio)] but the two determinations which show 0.00% of  $\text{CO}_2$  (p. 360, table 1) yield results

\* The Ca/P ratio might be expressed better as an atomic ratio rather than a weight ratio. This is particularly true when considering analyses which indicate several ions occupying one sort of position in the lattice.



which differ by 0.14. If compared with the theoretical value the difference is 0.10 for one of these determinations, indicating an error of about five per cent, for the purpose to which these results were put. There is no way to ascertain the maximum error in terms of their determinations, but the method used for P is shown by its authors to give errors frequently as high as ten per cent of the amount present, and in the presence of certain interfering substances errors as high as 40% were obtained for single determinations.

Unfortunately about half of the determinations tabulated by Thewlis, Glock and Murray are within the limit of error. The determinations outside of the limit of error are greater than the theoretical value and these show various amounts of  $\text{CO}_2$ .

On the other hand, it is noteworthy that four recent analyses (1, 6, 9, 17) by four different analysts have indicated small, but unmistakable, amounts of carbon substituting for phosphorus in the apatite lattice, supporting the hypothesis presented by the writers. Three of these analyses (1, 6, 9) also indicate the entrance of carbon into the lattice in a manner such as to displace calcium. In addition to these analyses of minerals, the analytical determinations of W. D. Armstrong (13) also indicate these same sorts of ionic substitution in dental enamel and dentine.

#### OPTICAL DATA

The birefringence ( $\Delta$ ) of apatites containing appreciable amounts of  $\text{CO}_2$  shows [when these are distinctly crystalline] a significant increase above that of fluor-apatite and there is likewise a decrease in the mean refractive index ( $n_\mu$ ). A few typical determinations are as follows:  $n_\mu = 1.631$ ,  $\Delta = 0.008$  (16);  $n_\mu = 1.624$ ,  $\Delta = 0.008$  (17);  $n_\mu = 1.618$ ,  $\Delta = 0.017$  (18);  $n_\mu = 1.626$ ,  $\Delta = 0.0075$  (19);  $n_\mu = 1.631$ ,  $\Delta = 0.0067$  (20);  $n_\mu = 1.618$ ,  $\Delta = 0.012 - .019$  (21).

Table 1 indicates the effect of various sorts of ionic substitution upon the optical properties of apatite. All of the common types of substitution have been considered, whether they substitute for Ca, P, F or O. H. Hausen (22) describes the optical properties of most of the members of the apatite group, but references are given to other special sources in several instances. Whenever the data were insufficient to permit conclusions based on actual measurements, theoretical predictions have been based upon the empirical ionic refractivities calculated by J. A. Wasastjerna (28). In all cases the measured results given in Table 1 are consistent with the theoretical expectations.

It is immediately noticeable that only four sorts of ionic substitution can be expected to decrease the mean refractive index, namely, C, F, Mg, and Na. All of these elements are encountered in bone and tooth sub-

stance but only the first of these occurs in appreciable amounts (greater than one per cent). None of these constituents which decrease the refractive index, nor any of the other constituents, would be expected to increase appreciably the birefringence except carbon. As W. L. Bragg (31) has demonstrated in connection with calcite, the strong birefringence is to be accounted for in terms of the polarization caused by

TABLE 1  
EFFECT OF CERTAIN IONIC SUBSTITUTIONS UPON THE  
OPTICAL CONSTANTS OF APATITE\*

Ion	$n_{\mu}$	$\Delta = \gamma - \alpha$	References
C	decrease	large increase†	Hausen (22); others (16-21)
F	decrease	very slight	Hausen (22); Kind (23)
Cl	increase	very slight	Hausen (22)
OH	increase	very slight	Burri, Jakob, Parker and Strunz (24)
Sr	increase	very slight	Smith and Prior (25)
Mn	increase	very slight‡	Quensel (26); Landes (27)
Na	decrease	slight	Kind (23); Wasastjerna (28)
K	increase	—	Wasastjerna (28)
Mg	decrease	—	Idem.
rare earths	increase	slight	Kind (23); Boldyrev (29)
S, Si	§	slight	McConnell (30)

\* The values for fluor-apatite are:  $n_{\mu} \geq 1.631 \leq 1.634$ ;  $\Delta \geq 0.003 \leq 0.005$ .

† Occasionally a carbonate-apatite is reported as having birefringence as low as 0.005. The variability of the birefringence probably is to be explained in terms of variation in the distribution of carbon between the calcium and phosphorus positions.

‡ H. Hausen inadvertently gives the birefringence of mangan-apatite from New Ross, Nova Scotia as 0.007. Actually this value is a maximum difference among several measurements and the birefringence is described as low by T. L. Walker and A. L. Parsons (*Univ. Toronto Studies, Geol. Series*, 17, 46, 1924).

§ Although measurements of refractive indices of ellestadite have been reported, the natural material contained an appreciable amount of chlorine. The optical properties of synthetic ellestadite prepared by R. Klement (*Naturwissenschaften*, 27, 57, 1939) have not been reported as yet.

carbon atoms forming planar  $\text{CO}_3$  groups. There is no other plausible explanation, immediately apparent, except that  $\text{CO}_3$  groups account for a considerable portion of this increase in birefringence. The effect of  $\text{CO}_4$  groups cannot be considered in the light of the rather imperfect knowledge concerning this configuration, but these tetrahedra may be distinctly asymmetric and further contribute toward the superior birefringence of these substances.\*

\* The fact that carbonate-apatites are frequently biaxial suggests that they do not exactly conform to the symmetry requirements of  $C6_3m$ . The discrepancy in this respect, however, is so small as to escape detection by any of the usual x-ray methods.



Some of the measurements of the optical properties of carbonate-apatites have been made on finely fibrous materials which appeared slightly cloudy on microscopic examination, and it has not been possible to demonstrate in all instances that  $\text{CaCO}_3$  or carbonic acid was not present as an interstitial impurity, although none was capable of detection. Nor has a description been given of a non-fibrous carbonate-apatite which is completely homogeneous, at the same time comparing it with fluor-apatite. The carbonate-apatites that occur at Magnet Cove, Arkansas, are of special interest in this respect.

#### DESCRIPTION OF SPECIMENS FROM MAGNET COVE

One sort of apatite at Magnet Cove occurs in association with nepheline, a light-colored mica and schorlomite. This occurrence was briefly mentioned by J. F. Williams (32) but no mention was made of the carbonate-apatite which sometimes occurs with the fluor-apatite. This material will be referred to as type *A* to distinguish it from type *B* which is associated with titanium oxide, and more or less remotely associated with coarsely crystalline calcite and feldspar. The paragenesis of type *B* cannot be clearly ascertained because the specimens came from ground which had been disturbed by mining operations.

Both types are characterized by acicular crystals which are probably not primary, but pneumatolytic or hydrothermal in origin. Carbonate-apatite is found in association with both types of fluor-apatite. The carbonate-apatite occurs as cavity fillings and replacements. It probably formed through attack of the fluor-apatite by hydrothermal solutions rich in carbonic acid, with subsequent precipitation of carbonate-apatite in the same crystallographic orientation upon the residual crystals of fluor-apatite.

#### *Type A*

When the specimens are proportionally richer in apatite, the crystals frequently show a preferred orientation and a material with porcelaneous luster occurs interstitially, sometimes replacing the fluor-apatite and sometimes as overgrowths partially filling cavities (Fig. 1). The appearance of this porcelaneous substance differs distinctly from that of the fluor-apatite which exhibits the usual vitreous luster. Qualitative microchemical tests indicate that the vitreous material is essentially fluor-apatite, whereas the porcelaneous substance is a carbonate-apatite, which possibly contains fluorine also. Because of the difficulties which attend the determination of alkalies in these substances, potash and soda were not determined, but this is of little significance and has no bearing on the conclusion that one of these substances contains sufficient  $\text{CO}_2$  to be considered a carbonate-apatite while the other does not.

On microscopic examination the carbonate-apatite exhibits a superior birefringence. In basal sections (Fig. 1) the carbonate-apatite occurs as sectors about a core of fluor-apatite. These sectors are biaxial with small optic angle. They exhibit zonal lamination and are somewhat cloudy, but there is no evidence of the presence of calcite or aragonite. Because the material of type *A* is cloudy and not completely homogeneous, it probably cannot be concluded with certainty that calcite and aragonite

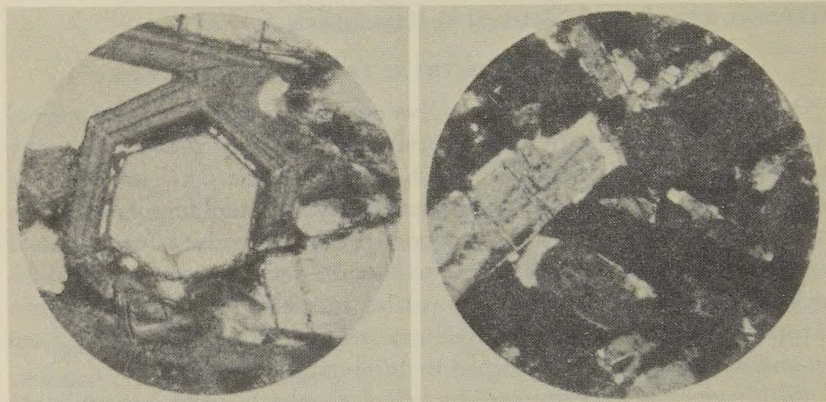


FIG. 1. Type A. Basal section of fluor-apatite with laminated incrustation of carbonate-apatite. The sectors of carbonate-apatite are biaxial with small optic angle, and the acute bisectrix is essentially parallel to  $c$  of the fluor-apatite. One nicol. Magnification 40 $\times$ .

FIG. 2. Type B. Section showing replacement of fluor-apatite by carbonate-apatite. The former is dark to medium gray in the photograph and the latter is light gray to white. Nicols in crossed position. Magnification 24 $\times$ .

are completely absent, although  $\text{CaCO}_3$  could not be detected in any of these specimens.

### *Type B*

Although the material of type *B* does not contain the substance with porcelainous luster, it liberates  $\text{CO}_2$  when small fragments are placed in warm dilute  $\text{HCl}$ . It was immediately apparent on microscopic examination that two sorts of apatite were present here also, because of the superior birefringence of certain portions of the crystals. Indeed, were it not for the differences in refractive indices of the two portions of the crystals (immediately apparent when employing both nicol prisms) one might suppose that he were dealing with homogeneous crystals of a single substance. It is significant that these crystals are not cloudy, but completely transparent, and the portions with superior birefringence are essentially homogeneous. Some small inclusions occur in the portions



with inferior birefringence but these are usually completely absent in the more highly birefringent material.

In order to ascertain that the more highly birefringent portions were surely carbonate-apatite, fragments of crushed material were examined under the microscope during their treatment with acid. The fragments were first immersed in water and covered. After selection of a prismatic cleavage fragment of uniform thickness which exhibited considerable difference in retardation in different portions, the water was displaced by HCl. Always the portion having the greater birefringence dissolved more rapidly, and frequently the bubble of  $\text{CO}_2$  could be observed to form near the more highly birefringent portion of the fragment.

A thin section was likewise treated with acid after cutting away a portion of the cover glass and removing the Canada balsam with xylol. The more highly birefringent portions were again observed to liberate bubbles of  $\text{CO}_2$ . To be sure, bubbles formed near portions of the section which did not exhibit a maximum retardation, but the orientation of the crystals which gave rise to the bubbles was not ascertained except in those cases where the retardation was greatest. It cannot be said with certainty, therefore, that the material with inferior birefringence does not contain  $\text{CO}_2$ , but there is sufficient reason to believe that  $\text{CO}_2$  is not nearly so abundant in this material.

Because of the rather intimate association of the two varieties of apatite, their identical appearance, and the small dimensions of the crystals, it was not possible to make a microchemical test on one of these substances with certainty that the other was absent. However, the tests already mentioned, together with the fact that carbonate-apatites nearly always exhibit a superior birefringence and a lower mean refractive index, are quite sufficient to demonstrate that one of these substances is a carbonate-apatite while the other is more nearly comparable to ordinary fluor-apatite.

The refractive indices were determined by the immersion method, employing a yellow filter (Wratten No. 90), with the following results:

Fluor-apatite (*B*)  
 $\omega = 1.633$   
 $\epsilon = 1.629$   
 (both  $\pm 0.001$ )

Carbonate-apatite (*B*)  
 $\gamma = \omega = 1.632$   
 $\alpha = \epsilon = 1.625$   
 (both  $\pm 0.002$ )

The fluor-apatite is uniaxial and negative. This may or may not be true also for the carbonate-apatite, because it is not possible to state that a basal section of carbonate-apatite was ever positively identified as such, because of the difficulties already mentioned.

In sections cut parallel to *c*, however, the difference in retardation between the carbonate-apatite and the fluor-apatite is about  $200\text{m}\mu$ .

This is shown in Fig. 2, which was photographed by utilizing both nicol prisms and a yellow filter. The large crystal of fluor-apatite (gray in the photograph) produced a gray interference color, while the carbonate-apatite portion (nearly white) produced a yellow interference color, the orientation being the same for both substances.

#### SUMMARY AND CONCLUSIONS

Additional evidence for the existence of carbonate-apatites is presented as a result of the microscopic examination of specimens from Magnet Cove, Arkansas. The carbonate-apatite (type *B*) is non-fibrous, completely colorless, and free from inclusions, but liberates  $\text{CO}_2$  when treated with  $\text{HCl}$ . The carbonate-apatite occurs as a replacement of fluor-apatite and is probably hydrothermal in origin.

Carbonate-apatites have optical properties distinct from those of fluor-apatite and these differences cannot be accounted for in terms of contamination by  $\text{CaCO}_3$ . The birefringence of carbonate-apatites is higher than that of fluor-apatites and the mean refractive index is lower. Carbonate-apatites may be biaxial with small optic angle.

The conclusion that carbonate-apatites are to be explained on the basis of contamination by  $\text{CaCO}_3$  is unwarranted in view of the complete absence of experimental evidence to support this contention. The occurrence of submicroscopic particles of  $\text{CaCO}_3$  in apatite has not been demonstrated, even in those cases where the carbonate-apatite appears cloudy on microscopic examination and, presumably, cannot be demonstrated when the material appears perfectly clear and transparent.

It is reasonable to consider the mineral substances of teeth and bones as hydroxy-apatite, but this view in no way interferes with the evidence indicating that they also contain carbonate-apatite. The substance of teeth and bones should properly be called a carbonate hydroxy-apatite or dahllite.

The criteria that can be used for the recognition of mineral carbonate-apatites cannot be applied directly to the substance of teeth and bones, e.g., microscopic observations are hindered by the presence of organic matter (with high birefringence). Moreover these substances are not distinctly crystalline, but cryptocrystalline. If biochemists are unwilling to accept the implications to be drawn from the mineral kingdom regarding the carbonate hydroxy-apatite composition of teeth and bones, they necessarily restrict the scope of their hypothetical considerations.

#### ACKNOWLEDGMENTS

The writers are indebted to Dr. H. W. Nichols, of the Field Museum of Natural History, Chicago, who supplied the specimens with por-



celaneous luster. Mr. Monte Ledford, of the Titanium Corporation, Malvern, Arkansas, kindly supplied other specimens and assisted one of us (D. McC.) in collecting material at the locality.

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# ALLANITE FROM BARRINGER HILL, LLANO COUNTY, TEXAS\*

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## ABSTRACT

Allanite from Barringer Hill, Llano County, Texas, has been analyzed, with especial attention to the "lead-ratio." The resulting value, 0.428, indicates either a large accumulation of "common" lead or extensive alteration. A complete analysis, petrographic studies, and other data are given.

The pegmatites of Barringer Hill, Llano County, Texas, have yielded many specimens of radioactive minerals, a number of which have been analyzed with especial attention to the "lead-ratio." This work has been summarized by A. Holmes (1931) and (1937), so detailed references and discussion need not be given here. It should be pointed out that only one mineral from this locality, an uraninite analyzed by Hillebrand and by Mackintosh, yielded a "lead-ratio" that was completely acceptable to Holmes. Most of the other minerals thus analyzed—mackintoshite, yttracrasite (from Burnet County), thorgummite, yttrialite and fergusonite,—he considered either to be in the metamict condition or to be alteration products. In the early studies of the "lead-ratio" method of geologic time determination, the varying results obtained from the analyses of Barringer Hill minerals were used to discredit the method temporarily, though, as Holmes has shown, part of the difficulty has since been removed by the discovery of the correct rôle of thorium as a radioactive element in the production of lead. No corrections for "common" lead have been applied to any of the work, as in some cases not enough material for isotope studies was available, and most of the work was done before the need for this correction was realized.

Allanite has been reported from this locality by Dana (1914) (1932), F. L. Hess (1908), and K. K. Landes (1932), but as far as can be ascertained, has not been analyzed. In 1933 the writer received from Dr. A. C. Lane, Chairman of the Committee on Measurement of Geologic Time, a specimen of this mineral, originally furnished by Mr. C. L. Brock, Director of the Houston Museum of Natural History, Houston, Texas. This specimen was collected by Mr. Brock at Barringer Hill on April 20, 1931, on the occasion of a trip made shortly before the locality was to be flooded for reservoir purposes. An account of this trip has appeared in print [C. L. Brock (1932)].

Dr. Lane tested the sample for radioactivity in the spinthariscopes,

\* Contribution from the Committee on Measurement of Geologic Time, Division of Geology and Geography, National Research Council.



and reported it to be "about  $\frac{1}{4}$  as active as the kolm of Westergötland, Sweden."<sup>1</sup> As no more minerals would presumably be available for analysis from this locality, the specimen was turned over to the writer. It has been studied in connection with a systematic investigation of allanite as a possible "age-index" mineral.

The sample as received was in one irregular mass, weighing 535 g., showing no crystal nor cleavage faces, but with fresh fracture surfaces. A few fragments of feldspar adhered to it. The outside portions, where the mass had been in contact with other minerals, showed a very thin zone of greyish altered material, a fraction of a mm. thick, which was firmly attached to the unaltered main portion. None of the brown, ochreous alteration products that often accompany allanite were visible.

A flat surface was ground on one side for radiographic examination. On wiping this off with acetone a very faintly visible outer zone, about 2-3 mm. wide, could be seen, suggesting the possibility of slight surface alteration.

An autoradiograph was made, using 23 days exposure. The plate, on development, showed uniform, but exceedingly faint darkening, too faint for reproduction, indicating a very low proportion of radioactive elements, but an apparently uniform distribution.

Material for analysis was taken from a portion of the main mass that showed an apparently uniform appearance. The outer zones mentioned above were carefully avoided. Examination of the coarse fragments under the binocular microscope showed no foreign matter, and this sample was ground to a fine powder, without sieving. The steel muller and agate mortar used were carefully cleaned before use to avoid possible contamination with other minerals, especially those carrying lead.

Several determinations of the lead, thorium, and uranium content were made, as listed in Table 1.

TABLE 1. Pb/Th+U, BARRINGER HILL, TEXAS, ALLANITE

Analysis No.	Weight sample, g.	Weight PbSO <sub>4</sub> , g.	≈% Pb	Weight ThO <sub>2</sub> , g.	≈% Th	Weight U <sub>3</sub> O <sub>8</sub> , g.	≈% U
1	10.0996	0.0248	0.168	—	—	—	—
2	8.97805	0.01317	0.100	0.07500	0.734	0.00350	0.033
				0.07280	0.713	0.00250	0.024
				0.07140	0.699	0.00450	0.043
4	2.72738	0.00400	0.103	—	—	—	—

Averages: % Pb 0.124  
 % Th 0.715  
 % U 0.033

$$\frac{\text{Pb}}{\text{U} + 0.36 \text{ Th}} = 0.428.$$

<sup>1</sup> Lane, A. C., Private communication.

Analyses 1 and 4 were lost by accident after completion of the lead determinations. In Analysis 2, lead was determined on the entire sample, thorium and uranium on three aliquots. The value 207.90 was taken for the atomic weight of lead, based roughly upon the relative proportions of uranium and thorium. Little difference, if any, in the computed percentage of lead would result, were the value for "common" lead, 207.21, used instead. In the case of minerals carrying considerable percentages of lead, the proper value for this "constant" must be applied to obtain correct results.

Special precautions were taken, as usual, to ensure that none of the three elements determined above had escaped quantitative determination. The acids, ammonia, and sodium carbonate used in the decomposition of the mineral and in the determination of lead were redistilled, (or re-crystallized), to ensure freedom from traces of lead. Experience has shown thorium and uranium are not present in "C.P." reagents in analytically significant quantities. The mineral was decomposed by repeated evaporation and dehydration with hydrochloric acid, to avoid "loading" the sample with large amounts of sodium carbonate. Silica was removed with hydrofluoric acid, and a small residue brought into solution with acid, followed by fusion with sodium carbonate. Lead was separated as sulfide, purified several times by precipitation as sulfate and sulfide, and weighed as sulfate. Thorium was separated by the peroxynitrate method, then precipitated as oxalate and weighed as oxide. Uranium was separated from iron, etc., by repeated treatment with ammonia and ammonium carbonate, separated from a trace of "heavy metals" by their precipitation with cupferron, finally precipitated with carbonate-free ammonia, and weighed as the mixed oxide,  $U_3O_8$ .

The "lead-ratio" of 0.428 derived from these analyses is, obviously, valueless in determining the age of the mineral. Either a large quantity of "common" lead—several times the amount of "radiogenic" lead—is present, or else alteration has progressed to such an extent that thorium and uranium, or one of them, have been extensively leached. Unfortunately the lead sulfate was not recovered from the analytical residues, so that the proportions of the various isotopes cannot be determined by mass spectroscopy. Enough of the analytical sample is available, should it seem desirable to do so in the future.

When we compare this "lead-ratio" with those quoted and discussed by Holmes (*Nat. Res. Council. Bull.* **80**, p. 333), we find that it is of the same general order as those found by Mackintosh for two samples of fergusonite (analyses H and I), where values of 0.284 and 0.566 were obtained. Holmes suggests that lead may have migrated from mackintoshite (analysis C), "ratio" 0.102, to the fergusonite which accompanies



it. He also points out that fergusonite, as a niobate of the rare earths, is likely to be metamict.

The field evidence available offers no evidence as to a possible transfer of lead from some other mineral to this allanite, but the petrographic studies (see below) show that, in all probability, it is in the metamict condition, i.e. the originally anisotropic mineral has become fully isotropic.

Galena or other sulfides, which might possibly carry lead, have not been reported from the pegmatite. However, V. M. Goldschmidt (1938) points out that lead is concentrated in potash feldspars, replacing potassium (p. 93). It may be that the alteration of the allanite has permitted the transfer of lead from the adjacent feldspars. At any rate, transfer of lead from some other mineral is the probable reason for the high "lead-ratio," as there seem to be no secondary alteration products higher in thorium or uranium present. The leaching of these elements may usually be made evident by the occurrence of gummite or gummite-like secondary minerals in cracks and on crystal surfaces.

A small sample of the mineral, in the form of coarse fragments, was sent to Dr. W. D. Urry, then at the Massachusetts Institute of Technology, to see what results could be obtained by the possible application of the helium-radium-thorium ratio. He reports:<sup>2</sup>

"Helium data, Llano County, Texas, allanite.

Date	Weight	Remarks	Result
Feb. 5, 1935	0.070 g.	Fluxed with 7.5 g. Na <sub>2</sub> CO <sub>3</sub>	1.98 × 10 <sup>-2</sup> cc. He/g."

Using the analytical data for uranium and thorium given in Table 1, Urry calculates the "helium ratio,"

$$\frac{\text{He}}{\text{U} + 0.27\text{Th}} = \frac{1.98 \times 10^{-2}}{3.3 \times 10^{-4} + 0.27 \times 7.15 \times 10^{-3}} = 8.76,$$

which is equivalent to a "lead-ratio" of 0.010. This is, of course, far too low for a pre-Cambrian formation. On the basis of the analysis of the uraninites mentioned by Holmes, and on the stratigraphic relationships, the age is at least, pre-Upper Cambrian. The metamict condition of the mineral is presumably responsible for this loss of helium.

A complete analysis of the mineral was also made, to be sure the specimen was indeed allanite, to see if lead, uranium, or thorium had been missed at any point in their determination, and to complete the record as far as possible. Results are in Table 2.

<sup>2</sup> Private communication.

TABLE 2. ALLANITE FROM BARRINGER HILL, TEXAS

Pb	0.12%	Ce <sub>2</sub> O <sub>3</sub>	10.58	TiO <sub>2</sub>	0.89
ThO <sub>2</sub>	0.82	La <sub>2</sub> O <sub>3</sub> , etc.	11.97	SnO <sub>2</sub>	0.33
U <sub>3</sub> O <sub>8</sub>	0.04	Yt <sub>2</sub> O <sub>3</sub> , etc.	0.81	H <sub>2</sub> O (-110°)	0.22
SiO <sub>2</sub>	29.89	FeO	8.49	H <sub>2</sub> O (+110°)	1.84
CaO	8.48	Fe <sub>2</sub> O <sub>3</sub>	6.41	K <sub>2</sub> O	0.08
SrO	0.00	Al <sub>2</sub> O <sub>3</sub>	19.09	Na <sub>2</sub> O	0.16
MgO	0.15				
Total					100.37

Density = 3.54 [25°/4°]

J. P. Marble, *Analyst*.

The amount of uranium present was so small that determination of both UO<sub>2</sub> and UO<sub>3</sub> was not feasible, especially in the presence of large amounts of FeO and Fe<sub>2</sub>O<sub>3</sub>. The effect on the total of recalculating to either oxide would be negligible. The rare earths, after removal of cerium, apparently belong almost entirely to the lanthanum sub-group, as is usual in allanite. The presence of tin was confirmed by a qualitative test on the filtrate from the PbSO<sub>4</sub> of one of the main analyses. It has been reported also in allanite from Nelson County, Virginia.<sup>3</sup> The analysis in the present paper shows the same general relations of the same oxides as in analyses of allanites from other localities. At any rate, this mineral is much closer chemically to a "typical" allanite than to any other mineral.

The optical properties were most kindly and carefully determined by Miss Jewell J. Glass of the U. S. Geological Survey,<sup>4</sup> as follows:

Allanite from Barringer Hill, Llano County, Texas, U.S.A.

By alteration or inversion this specimen is *isotropic*.

Color: In transmitted light the color is smoky-brownish black, resembling black spinel.

Translucent.

Luster: Resinous or pitchy.

Index of refraction:  $n = 1.716$ .

The specimen is apparently homogeneous, being completely isotropic throughout in all of the five areas observed.

This agrees with the high "lead-ratio," the low helium content, and the considerable water content in suggesting that alteration has taken place to a considerable degree. Apparently a similar fate has overtaken nearly all of the radioactive minerals in this pegmatite, so that the age still rests on the uraninite mentioned at the beginning of this paper.

The net results of this investigation are to add one more to the already

<sup>3</sup> Dana: System of Mineralogy, 6th Ed., p. 524, analysis 34.

<sup>4</sup> Private communication, Oct. 24, 1939.



large number of allanite analyses on record, to indicate the probability of alteration in the specimen studied, and once more to indicate the urgent need of optical, radiographic, and isotope control in all analyses made for age determination purposes.

The courtesy of the Director of the U. S. Geological Survey and of the Assistant Secretary of the U. S. National Museum for the use of laboratory and other facilities is gratefully acknowledged. The aid of Miss Glass of the U. S. Geological Survey, and of Dr. W. D. Urry of the Geophysical Laboratory of the Carnegie Institution of Washington has made the work more complete.

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## MEMORIAL OF WILLIAM E. FORD

ADOLPH KNOPE, *Yale University, New Haven, Conn.*

Professor William Ebenezer Ford died on March 23, 1939, in New Haven, Connecticut, at the age of sixty-one. His sudden, unexpected death came as a profound shock to his colleagues at Yale University, for although he was on leave because of heart attack he had announced that he was beginning to feel better and was planning to return to his duties later in the spring. The son of William Elbert Ford and Caroline Aby (Bishop) Ford, he was born in Westville, a suburb of New Haven, Connecticut, on February 18, 1878. He prepared for college in the schools of New Haven and entered the Sheffield Scientific School of Yale University in 1896. He took the course in chemistry, which then required only three years (later, during the reorganization of the University in 1919 lengthened to four years), and graduated in 1899 with the degree of Bachelor of Philosophy.

He was then appointed assistant in mineralogy to Professor Samuel L. Penfield, of the Sheffield Laboratory of Mineralogy, Yale University, and he continued his studies in mineralogy and crystallography. Ford was indeed fortunate to have come under the guidance of Penfield, a kindly mentor and versatile, productive investigator. In his graduate years Ford published three papers jointly with Penfield and three independently. Two independent papers deal with the establishing of the chemical composition and formulae of two difficultly analyzable minerals—dumortierite and axinite, and the third paper announces the discovery and description of a new mineral—the copper telluride, rickardite. After receiving the degree of Doctor of Philosophy in 1903 he was appointed instructor in mineralogy, and in 1906 was advanced to the rank of assistant professor of mineralogy. In that year occurred the untimely death of Professor Penfield, who was cut off in the full tide of his productivity, and Dr. Ford became his successor. Mineralogy was a required subject in the Sheffield Scientific School at that time, and this requirement necessitated a large amount of routine teaching: the laboratory course in determinative mineralogy had an attendance of 100 to 150 undergraduates; furthermore, crystallography and descriptive mineralogy were taught to classes of 40 or 50. In addition two advanced courses were given to graduate students. In spite of these heavy duties, much research was accomplished. In 1909 Ford assisted Edward S. Dana in preparing the Second Appendix to Dana's System of Mineralogy, and as time went on he became more and more immersed in the task of revising, rewriting, and keeping up to date the several Dana works on mineralogy—the Manual, the Textbook, and the System. With a fine





WILLIAM E. FORD  
1878-1939

loyalty, he submerged his own individuality in keeping alive these books.

In 1920 Ford was appointed professor of mineralogy and was made a member of the Governing Board of the Sheffield Scientific School, and served in these positions until his death in 1939. In the fall of 1920 he married Mary Treat Jennings of Rochester, New York, a marriage that proved to be ideally happy. They particularly delighted "to go down to the Cape," to spend the vacations in their much-loved cottage on Cape Cod; and in later years when Ford was giving all his spare time to the revision of Dana's System he preferred to do his scientific work there.

Among the more notable of Ford's contributions to mineralogy were his papers dealing with the influence of chemical composition on the optical properties of isomorphous groups of minerals. Characteristic of these studies is the principle now regarded as almost axiomatic that chemical composition, optical properties, and other physical properties should all be obtained on the same specimen. The forerunner of these studies was his paper in 1910 on "The effect of the presence of alkalis in beryl upon its optical properties." A correlation between content of the alkali oxides ( $\text{Li}_2\text{O}$ ,  $\text{Na}_2\text{O}$ ,  $\text{K}_2\text{O}$ , and  $\text{Cs}_2\text{O}$ ), specific gravity, and optical properties was definitely established.

A more ambitious study was that on the amphiboles, published in 1914. A series of eleven analyses of amphiboles had been made by Dr. F. C. Stanley under the guidance of Professor Penfield, and constituted one of the few series of authoritative analyses made up to that time. These analyses, mineralogists should recall, established that hydroxyl is a constituent part of the amphibole composition long before  $x$ -ray analysis re-affirmed it. "In studying the literature of the last twenty-five years," Ford remarked, "it is surprising to find in how few cases both an analysis and an optical description of the same amphibole have been recorded." Therefore Ford logically completed the investigation of the amphiboles begun by Penfield and carefully measured their optical properties. With this data and that of seven other analyzed amphiboles, Ford discussed the correlation between chemical and optical properties. It was fundamental work on a complex problem, and as is well known, in spite of the immense amount of work that has since been done by many other investigators, the amphiboles have not yet been completely set in order.

Another study was that of 1915 on the relations between the chemical, optical, and other physical properties of the members of the garnet group. This study established that the index of refraction and specific gravity of any garnet depend in a simple way on its chemical composition. The limited miscibility of andradite was confirmed. A recent re-examination of the problem, based on 85 new analyses made since 1915,

has verified the direct relationship between chemical composition and physical properties found by Ford to exist in the garnet group.<sup>1</sup> The last of these studies, published in 1917, was a penetrating investigation of the calcite group, comprising calcite, dolomite, magnesite, rhodochrosite, and siderite. From the large difference between the molecular volume of calcite and those of the other four carbonates, it was thought that calcite should show only a limited miscibility with the other carbonates, whereas these others, especially the rhodochrosite, siderite, and magnesite, should be completely miscible. This theoretical expectation was well substantiated by an appeal to the chemical analyses of the actual minerals. Since the lattice of calcite does not alter in size when magnesite, rhodochrosite, or siderite enter as solid-solution components, it was inferred that the specific gravity of these components must change, e.g., pure siderite has a specific gravity of 3.89, but when it enters into calcite its specific gravity becomes 3.148. Finally, triangular diagrams were constructed to show in simple form the relations that exist between the chemical composition, specific gravities, and refractive indices of these members of the calcite group.

The increasing absorption of Dr. Ford in the task of keeping the several Dana works on mineralogy up-to-date has already been mentioned. In response to the request of Professor E. S. Dana, Ford brought out in 1912 a new edition of the Manual, the thirteenth. The Manual had first been published by James Dwight Dana in 1848, and had been revised last in 1887. It was entirely rewritten by Ford and the illustrations were vastly improved, among other things photographic plates of minerals were added, so that it was practically a new book. The chapter on petrography was omitted and the title of the book was changed back to its original form and was to be known in the future, wrote Ford, as "Dana's Manual of Mineralogy." In 1929, when the Manual had reached a total issue of 41,000 copies, a fourteenth edition was brought out.

In 1915 Ford published the Third Appendix to Dana's System, which covered the period between January 1, 1909 and January 1, 1915. In that short time 180 new mineral names had been proposed, about one-third of which appeared to be well-established species. In 1920 Ford began the great task of revising Dana's System, the sixth edition of which had been brought out in 1892 by Edward S. Dana, the son of James Dwight Dana, in the form of a monumental revision of his father's work. It soon appeared that the output of mineralogic publications had grown so large that revision of the System could no longer be encompassed by a single individual. Ford was so fortunate as to obtain the

<sup>1</sup> Fleischer, Michael, The relation between chemical composition and physical properties in the garnet group: *Am. Mineral.*, **22**, 751-759 (1937).



cooperation of Professor Charles Palache in assembling the crystallographic data and Professor E. S. Larsen on the optical properties of the minerals. It further became evident that if the revision of the System were to be completed within a reasonable time, the aid of a number of full-time assistants was imperative, and for this purpose the Geological Society of America in 1936 made a generous grant. Unfortunately, Professor Ford's failing health, which had undermined his strength far more than even we who were in daily contact with him surmised, eventually forced him to the painful necessity of relinquishing all share in the great enterprise. To Professor Ford it was a deep satisfaction, however, that Professor Palache agreed to take over the responsibility of supervising the work to completion.

While the work on the revision of the System was in progress, Ford brought out in 1922 the third edition of E. S. Dana's Textbook of Mineralogy. Nearly twenty-four years had passed since the previous edition had been published, so that modernizing the volume necessitated lengthening it by 127 pages. In 1932 he issued the fourth edition of the Textbook of Mineralogy, which by that time had justly become known as the Ford-Dana textbook. It had grown by 143 pages, and it included brief descriptions of 220 new species. Because the time when the revision of Dana's System would be finished still seemed far off, Ford made a special effort that the new edition of the Textbook should include all known species of minerals and well-established varieties, so that this information might be conveniently available in at least one place in the English language.

Ford was a very human personage. As a teacher, he was notably successful and often inspired an interest in mineralogy in students whose major interests were in far different fields. Because of his informality and approachability, joined with a sympathetic interest in his students as individuals, he aroused in them a warm personal esteem. He was helpful and unselfish, and he took a keen delight in the successes of his friends. In the hearts of his colleagues and of his many former students he will always live in affectionate memory.

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## MEMORIAL OF FRANK NELSON GUILD

M. N. SHORT, *University of Arizona, Tucson, Arizona.*

Dr. Frank Nelson Guild, professor emeritus of the University of Arizona, died at his home in Tucson on March 12, 1939.

Dr. Guild was born at Jaffrey, N. H., December 28, 1870, the son of a Congregational clergyman. He attended the University of Vermont and received from that institution the degree of Bachelor of Science with high honors in 1894, and the degree of Master of Science in 1903. He studied later in Chicago, Paris, and Heidelberg, and at Stanford University which conferred on him the degree of Doctor of Philosophy in 1917.

After a year of teaching chemistry in the Chicago Manual Training School, and two years at Montana State College, he came to the University of Arizona in 1897 as professor of chemistry and mineralogy, and remained there after that time except for periods of study in Europe and at Stanford. His close contact with the best-known mineralogists in France, Germany, England, and Sweden was maintained up to his death.

In 1923 he became the head of the department of geology and mineralogy in the College of Mines and Engineering of the University of Arizona. In 1934 he retired because of failing health, but continued his research in optical mineralogy in a private laboratory in his home. A recognized authority in optical mineralogy, he was probably most widely known for his investigations of the paragenesis of the silver minerals. During a period of more than three decades, Dr. Guild trained numerous students who achieved success in the mining and allied industries. Always a scholar himself, he inspired many to appreciate pure science.

Dr. Guild served at various times by presidential appointment on the United States assay commission and the naval consulting board.

He was married in 1901 to Marilla Merriman. Mrs. Guild and a sister, Mabel Aenella Guild, survive him.

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## MEMORIAL OF WALDEMAR LINDGREN

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On November 3, Dr. Waldemar Lindgren succumbed to an illness which had made him an invalid for about a year. His death will be regretted not only by mineralogists but by all workers in the several fields of geological knowledge. Lindgren's breadth of geological attainment was equalled by few men. He not only appreciated the many facets of the science of geology, but he contributed to their advancement, and his publications ranged in subject matter from physiography to crystallography.

Waldemar Lindgren was born February 14, 1860, at Kalmar, Sweden, the son of Johan and Emma Lindgren. At a very early age he evinced an interest in mineralogy and geology, and particularly in mineral deposits. Indeed when only fourteen, he started his mineralogical excursions and visited the mining regions of central Sweden, and in the immediately following years, visited the mines of Norway and Germany.

When he graduated from the Kalmar Gymnasium in 1878, Lindgren entered the famous Royal Mining Academy at Freiberg, Saxony, where he studied under Richter, Winkler, Weisbach, and Stelzner. Lindgren took his opportunities seriously; he told me that he often took his mineralogy and petrography text books to bed with him, and read from them till he fell asleep. He graduated with the degree of Mining Engineer in 1882, but stayed for an additional year of graduate work.

In 1883, Lindgren quit Europe for the geological opportunities of America, and was fortunate enough to receive an appointment as assistant to Professor W. M. Davis, who was engaged in the Northern Transcontinental Survey under the general direction of Pumpelly. At the termination of this work, Lindgren showed his versatility by doing assaying, and by designing smelters.

Late in 1884, Lindgren entered the service of an organization with which he was to be identified for many years to come—the United States Geological Survey. This connection afforded him the opportunity for the extensive field work which was to lay the foundation for his subsequent generalizations. During this period of observation, he brought out masterpieces of description on mineral deposits; indeed his publications are still patterns used as guides by men training in this field. Moreover, he supplemented these descriptions by such keen analyses and correlations that he soon established himself as a leading theorist on the origin of ore deposits. Meanwhile, Lindgren slowly rose in rank to Chief of the Division of Metalliferous Geology of the United States



WALDEMAR LINDGREN  
1860-1939

Geological Survey, and eventually headed the organization as Chief Geologist.

In 1912, Lindgren resigned his post on the Geological Survey to assume the chair of William Barton Rogers Professor of Economic Geology and to become Head of the Department of Geology of the Massachusetts Institute of Technology, at that time located in Boston. He continued to hold this post until the usual retiring age of 70, but, by request of the staff, he consented to continue in this capacity until 1933. He was finally permitted to retire, at the age of 74, with the title of Professor Emeritus.

Shortly following the let-up of active academic duty, Lindgren's health began a gradual decline, and this general illness finally resulted in his death at the age of 79.

Many will think of Lindgren as a mining geologist or economic geologist, because his major contributions were in this field, but he was a great mineralogist as well. Indeed his knowledge of mineralogy, and his consistent mineralogical approach to many problems in ore genesis were important factors in his ability to make such telling contributions to that branch of science, and his stature as a mining geologist was in no small measure due to his habit of being, fundamentally, a mineralogist.

Lindgren put great emphasis on the mineralogical attainments of his students. They received intensive training in both the identification and the paragenesis of the minerals of selected suites of ores. When he received a new graduate student, it was with keen interest that Lindgren first discussed with him the results of the preliminary study of the mineralogy of the suite. I can recall several occasions, following such conferences, when Lindgren would saunter into my office, and, with an air of satisfaction, exclaim, "Well, ———— certainly knows his minerals!" This was always a priceless compliment.

Lindgren was a research worker of the first order, and he tried to inoculate his students with the spirit of research and self-reliance. Naturally, he attracted to himself, because of his prestige in economic geology, many students whose main aim was to become practicing mining geologists. Some of these men occasionally found Lindgren's instruction not specific enough for their needs, and attempted to get him to disclose just how to find ore and just how to proceed when examining a mine. To such men, Lindgren emphasized that it was his aim to teach the fundamentals of the science, in which he hoped they would become so steeped, that they would be able to apply the general principles to any problem with which they were presented.

Lindgren's greatest contribution to mineralogy was that he supplied that science with a well-authenticated theory of mineral origin, genesis,



and formation. This theory acts as a general framework upon which the various branches of mineralogy hang. Without it, vein mineralogy appears to be a field unconnected with ore mineralogy, and without it, mineralogy degenerates into the shallow fields of mineral collection and mineral description. Lindgren developed this theory by recognizing the merits of a number of scattered suggestions bearing on mineral genesis which had already been made, giving them his own particular emphasis, and adding to them original contributions. He integrated these many theoretical bits together into a general theory, and so thoroughly substantiated the entire theory and its parts, that it has come to be recognized as *the* theory of mineral deposition.

Among the several things which Lindgren emphasized are: the ultimate magmatic origin of mineralization; the classification of mineral deposits into temperature groups; the use of geological thermometers; mineral zoning both radially and in depth; metallogenetic provinces; the idea of replacement, especially volume-by-volume replacement; and the role of colloids in mineral formation. Lindgren's general theory of mineral deposition has been spread and become generally accepted, partly through his students, but largely through his book, "Mineral Deposits," which has passed through four editions and which is found in every mining camp.

By originating the abstracting journal which he named, "Annotated Bibliography of Economic Geology," Lindgren has put mineralogists deeply in his debt. In this innovation, Lindgren has not only contributed to his science by making it possible for the various investigators in the field to keep in touch with one another's progress and the progress in the border sciences, but he has also erected a lasting monument to his perspective and energy.

Among Lindgren's minor contributions to mineralogy, it should be recalled that he perceived the distinct natures of, and gave names to, the two minerals *coronadite*<sup>1,2</sup> ( $\text{PbMn}_2\text{O}_5$ ), and *violarite*<sup>3</sup> (now known to be  $\text{Ni}_2\text{FeS}_4$ ).

Lindgren has received several tokens of recognition of his mineralogical attainment. The mineral *lindgrenite* ( $2\text{CuMoO}_4 \cdot \text{Cu}(\text{OH})_2$ ) was named in his honor by Palache,<sup>4</sup> because of "His great contributions to

<sup>1</sup> Lindgren, Waldemar (with Hildebrand, W. F.), The copper deposits of the Clifton-Morenci district, Arizona: *Prof. Paper* 43, U. S. Geol. Survey, 103-106 (1905).

<sup>2</sup> Lindgren, Waldemar, Coronadite "Redivivus": *Am. Mineral.*, 18, 548-550 (1933).

<sup>3</sup> Lindgren, Waldemar, and Davy, W. Myron. Nickel ores from Key West Mine, Nevada: *Econ. Geol.*, 19, 313-314, 315-319 (1924).

<sup>4</sup> Palache, Charles, Lindgrenite, a new mineral: *Am. Mineral.*, 20, 484-491 (1935).

the knowledge of the mineralogy of the ore deposits and their paragenesis. . . .” In 1937, the Geological Society of London honored him with the Wollaston Medal, which is given, “to promote researches concerning the mineral structure of the Earth. . . .” He was the recipient of honorary doctor’s degrees from both Princeton and Harvard. In 1928 he received the third award of the Penrose Gold Medal from the Society of Economic Geologists, and in 1933 he received the Penrose medal of the Geological Society of America.

Lindgren was a fellow of the Mineralogical Society of America as well as a member or fellow of numerous geological societies, mining societies, and general science societies. He has served as President of the Geological Society of America, the Society of Economic Geologists, the Mining and Metallurgy Society of America, the Boston Geological Society, and as Vice-President of the American Institute of Mining and Metallurgical Engineers.

Lindgren was one of the most widely read men I have ever met. He read everything which came to hand, including the newspapers, but he had the knack of culling the high points rapidly, and without being detained by the embellishments of an article. He was a cultivated linguist. I have a personal knowledge that he spoke English, Swedish, German, French, Spanish and Italian, and was at home with classical Greek and Latin. I also am sure he could read many other languages without, perhaps, being sufficiently well acquainted with them to speak them. Moreover, he was not narrowly a scientist, but he was interested in, and was willing to converse on, any topic which was brought up in the course of a friendly conversation. His wide reading made him an astounding source of information on such occasions, and I was often surprised at the odd realms of knowledge which he had found sufficiently curious to warrant delving into.

For all his attainments, Lindgren was modest and friendly. He invariably carried himself with a quiet dignity, yet was easily approached. His students not only regarded him with a respect reserved for few, but also considered him a good fellow, in token of which they always invited him to their stag affairs.

With the passing of Waldemar Lindgren, the science loses one of those rare individuals who has been able to set up its mileposts, and those who knew him have lost a friend.

## MEMORIAL OF WILLIAM ARTHUR TARR

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William Arthur Tarr, mineralogist, geologist, inspiring teacher, died July 28, 1939, after an illness of long duration. He was fifty-eight years old.

Dr. Tarr was born at New Cambria, Missouri, on March 29, 1881, the son of John W. and Ida Elizabeth (Hill) Tarr. He took his undergraduate college work at the Oklahoma Agricultural and Mechanical College, receiving the Bachelor of Science degree in 1904. Having acquired a definite interest in geology, especially on the economic side, he entered the University of Arizona and was granted in 1908 the degree of Bachelor of Science in Mining Engineering. During the following year he was instructor in geology at that University. He entered the University of Chicago in 1909 as a graduate student and research assistant and completed the residence requirement for the doctorate in the spring of 1911. The degree of Doctor of Philosophy was conferred in 1916. In 1927 Oklahoma A. and M. conferred upon him the honorary degree of Doctor of Science. He had been married in 1905 to Coralynn Gertrude Neumann of Hillsdale, Oklahoma.

Dr. and Mrs. Tarr moved to Columbia, Missouri, in 1911, he having received an appointment as instructor in geology and mineralogy at the University of Missouri. He was promoted rapidly to assistant professor, associate professor, and in 1919 attained full rank. In addition to his regular teaching duties he served for several seasons as geologist in the Missouri Bureau of Geology and Mines, was consulting geologist for various petroleum companies, and taught in the summer sessions of the University of Chicago and the University of Missouri. He was a fellow of the Mineralogical Society of America, councilor from 1925 to 1929, vice-president in 1934; a fellow of the Geological Society of America and the American Association for the Advancement of Science. He held membership in the Mineralogical Society of Great Britain and Ireland, the American Association of Petroleum Geologists, and the Society of Sedimentary and Economic Mineralogists. He was a member of the Kappa Sigma social fraternity and of four scholarship and professional fraternities, Phi Kappa Phi, Sigma Xi, Gamma Alpha, and Sigma Gamma Epsilon. In the last named organization he was for nearly twenty years a member of the grand council, serving as national editor.

Dr. Tarr was a tireless investigator and his attention was given to a broad range of subjects. He has made many important contributions to



mineralogy, general geology, and economic geology, as the appended bibliography shows. One of his strongest interests, and the one for which he is perhaps best known, was the origin and nature of stylolites and various types of concretionary structures in sedimentary rocks. His interest was aroused early in the lead-zinc and contiguous barite deposits



WILLIAM ARTHUR TARR  
1881-1939

of Missouri. He was always a firm believer in the magmatic origin of these deposits. He was thus on the side of the minority among students of ore deposits, but he was an able champion of the magmatic hypothesis. He wrote on the coarser structures of igneous and sedimentary rocks, on physiography, on the origin and paragenesis of minerals, on the effect of heat on granite and other building stones. I think he wrote nothing on paleontology. He professed to know nothing about it. And yet on more than one occasion I have seen him on his knees, diligently and enthusiastically working with hammer and chisel to uncover invertebrate fossils. I mention this merely to emphasize the omnivorous and insatiable curiosity of this scientist. This broad interest never betrayed him into superficiality, however.

I would like to add a few words of personal tribute to him as a teacher and field companion. Some of my happiest recollections are of my early associations with him, first as a graduate student working under him, later as an instructor in the same department with him. He was a severe taskmaster during class or laboratory periods, always demanding our best effort. He never nagged or stormed when we slumped in our work, but led us back into good work habits, either by good humored "kidding" or by a dignified but effective rebuke. I well remember one day when the class in advanced mineralogy seemed completely awash. Dr. Tarr quietly picked up his books and notes, rose from his desk and said with a smile, "Gentlemen, I'm too busy to undertake a fruitless discussion with a class so totally uninformed. Let me know when you wish to meet with me again." I think we never again went to him unprepared.

He never tolerated inexact or vague expressions. All of his older students will remember his characteristic stock phrase during class discussion,—“Meaning by that?” The constant reiteration of that disconcerting question drilled into us the necessity of explicit and definite statements.

In the field he was an inspiring leader. He permitted no "grouching" on the part of himself or any members of the party. Drenching rains, muddy roads, flat tires, wind-flattened tents, weariness, all brought a laugh from him and therefore, eventually, from us. He maintained no austere dignity in the field, but joined in our spare time amusements and horseplay. We were camped one spring in the southeast Missouri lead district and for a week or two occupied a vacant bunk house at one of the mines. A large, bare steampipe ran the length of the building through each room and under each bed. I still shudder at the shock of the rude awakening we experienced every morning at six o'clock as he pounded vigorously on that pipe with his geological hammer, and his fiendish laughter as we suddenly hit the floor. That experience made me quite philosophical, two years later, regarding a top sergeant's early morning whistle and a rude command "to rise and shine." One of his more subtle practical jokes was perpetrated during the exploration of a large cave near the Missouri River. He directed his carbide light high upon the walls of the cave and showed us a blue-green material gleaming in a cavity, and vaguely said something about a rare mineral. Several of us made the rather difficult climb, racing to obtain possession of this rarity. When we reached our objective we found it to be candle grease left by a previous explorer. He was delighted at our chagrin.

His colleagues in science, his associates in the societies, and his former students mourn the untimely passing of Dr. Tarr, a friend, a very

human companion, a skilled teacher, and a scientist whose work was not completed. Their sympathies go out to Mrs. Tarr who was a constant and inspiring companion and co-worker with him in field and laboratory.

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## MEMORIAL OF EDWARD SYDNEY SIMPSON\*

It came as a great shock to his many friends and colleagues to hear of the death, due to heart failure, of Dr. E. S. Simpson, Government Mineralogist & Analyst for the State of Western Australia, at his home in South Perth, on August 30th. Dr. Simpson had a distinguished scientific career, and played a prominent part in the affairs of the Australian Chemical Institute in Western Australia; he was a foundation member and the first branch president—an office he subsequently held on two occasions. On completion of a period of ten years of continuous service he was presented with the gold medal instituted by the Branch for meritorious service. He also gained the H. G. Smith Memorial Medal.

Edward Sydney Simpson was born in 1875 at Sydney, N.S.W., the son of W. H. Simpson, merchant. He had a brilliant career at the Sydney Grammar School and the University of Sydney, winning numerous prizes and scholarships. He graduated in 1895 with the degree of B.E. in mining and metallurgy. His first appointment was as a research chemist at the Russell Silver Mine, Rivertree, N.S.W.; then followed a period as assayer at the Mt. Morgan Gold Mine, Q. In 1897, when only 22 years of age, he was offered the position of Mineralogist and Assayer and Chief Chemist to the W.A. Mines Department. From then onwards he devoted himself to the service of the State and to the Commonwealth, specializing in mineralogy and geochemistry. He took an active part in inaugurating the Perth Technical School, and later in the establishment of the Kalgoorlie School of Mines, of which he was for some years a member of the official board of control. In 1914 he received the degree of B.Sc. with honors in the University of Western Australia, and in 1919 the degree of D.Sc. was conferred on him for his thesis on "The Mineralogy of Western Australia."

In 1922 the chemical work of the Mines Department was reorganized, and Dr. Simpson was appointed Government Mineralogist and Analyst, with charge of the combined Health, Mineral, and Agricultural laboratories. He served for many years on various departmental committees connected with water supplies, foods, drugs and oils. He was a member of the State Committee of the Council for Scientific and Industrial Research and of the Australian National Research Council. In 1926, he was appointed Chairman of the Australian Committee for Ceramic Products connected with the International Union of Pure and Applied Chemistry.

Dr. Simpson's researches were mainly in the field of mineral chemistry, mineralogy, and crystallography. He was an authority on clays and rare minerals and also on meteorites, which he assiduously collected and ex-

\* Published in the Journal of the Australian Chemical Institute, September, 1939.



amined. He was the discoverer of a number of new minerals, including goongarrite, hydrothorite, pilbarite, picrocollite, tanteuxenite, maitlandite, manganilmenite, and manganomossite. During 40 years of his professional career, he published over 100 papers and monographs on scientific subjects, and, in 1932 a book "A Key to Mineral Groups, Species, and Varieties" (Chapman & Hall). He achieved international repute with researches dealing with the genesis, constitution, alterations, and economic applications of minerals, and was particularly successful in elucidating the true constitutions of a number of groups of unusually complex composition, such as the euxenite-polycrase group, the rutile-tapiolite group, and the chloritoid group. He was the first to demonstrate the nature of the relationship existing between the densities of individual members of an isomorphous group and the composition of their mixed crystals, and to apply it to the practical evaluation of tantalum ores. In later years, he was awarded the W. B. Clarke Memorial Medal of the Royal Society of New South Wales, and the Kelvin Medal of the Royal Society of Western Australia.

During recent years Dr. Simpson was engaged in collating and bringing up to date the results of over 40 years of research on minerals, with the object of publishing a book on the mineralogy of Western Australia. This book, which was more than half completed at the time of his death, was to have been on the lines of that of the French mineralogist Lacroix on "Minerals of France and Its Colonies," only more comprehensive. It is pleasing to know that Dr. Simpson made arrangements in his will for the completion of the book, which will be of inestimable value to the State and to mineralogists. The work will be a splendid memorial to a great mineralogist.

Dr. Simpson married in 1904 Miss Muriel Griffiths, an Australian violinist, and they had three children—Mr. Brian Simpson, Mr. William Simpson, and Mrs. St. Aubyn Barrett-Lennard, who survive him. Some time after the death of his first wife he married Miss Ruth Blanch Alcock, who also survives him. He was keenly interested in art and music, and in Nature in all its manifestations, taking a prominent part in the activities of the Royal Society of Western Australia. In his earlier years he was an enthusiastic yachtsman and tennis player. An ardent disciple of precision and thoroughness, and a man of very high ideals, he brought into all his dealings a rare culture and knowledge in many branches of learning.

Although essentially a mineral chemist and a mineralogist, his grip of other branches and applications of chemistry, engendered by the possession of a really first-class brain, made it a great and unforgettable privilege to work under him. A great believer in making available the results of original work, he encouraged others to publish their results. Not a few will miss his example but they will retain lasting memories.

# PROCEEDINGS OF THE TWENTIETH ANNUAL MEETING OF THE MINERALOGICAL SOCIETY OF AMERICA AT MINNEAPOLIS, MINNESOTA

PAUL F. KERR, *Secretary*.

The twentieth annual meeting of the Society was called to order Thursday, December 28th, at 2 P.M. in Parlor N of the Hotel Nicollet, Minneapolis, Minnesota, past-president A. N. Winchell presiding. The customary business of the Society was conducted, including reports of the officers of the Society and committees, summarized as follows:

MINUTES OF THE NINETEENTH ANNUAL MEETING, 1938.

REPORT OF THE SECRETARY

REPORT OF THE EDITOR.

REPORT OF THE TREASURER.

REPORT OF THE AUDITING COMMITTEE.

MEMORIALS TO W. E. FORD, F. N. GUILD, WALDEMAR LINDGREN, E. S. SIMPSON, AND  
W. A. TARR, PRESENTED BY DEAN EDWARD H. KRAUS.

After announcement of the Seattle meeting of the American Association for the Advancement of Science, the meeting was adjourned and followed by the scientific session. The report of the election of officers and fellows for 1940, and the reports of the officers are given in the following pages.

## ELECTION OF OFFICERS AND FELLOWS FOR 1940

The secretary announced that 327 ballots had been cast for the officers of the society as nominated by the Council. The officers for 1940 are as follows:

*President:* William F. Foshag, U. S. National Museum, Washington, D.C.

*Vice-President:* Ian Campbell, California Institute of Technology, Pasadena, California.

*Secretary:* Paul F. Kerr, Columbia University, New York, N. Y.

*Treasurer:* Waldemar T. Schaller, U. S. Geological Survey, Washington, D.C.

*Editor:* Walter F. Hunt, University of Michigan, Ann Arbor, Mich.

*Councilor, 1940-43:* D. Jerome Fisher, University of Chicago, Chicago, Illinois.

The secretary announced that according to the provisions of the constitution, the following have been elected to fellowship in the Mineralogical Society of America:

Guido Carobbi, Institute of Mineralogy, Florence, Italy.

Clarence N. Fenner, 64 Broad Street, Clifton, New Jersey.

Michael Fleischer, U. S. Geological Survey, Washington, D.C.

George E. Goodspeed, University of Washington, Seattle, Washington.

Joseph W. Greig, Geophysical Laboratory, Washington, D.C.

Frank F. Grout, University of Minnesota, Minneapolis, Minnesota.

Sterling B. Hendricks, U. S. Dept. of Agriculture, Washington, D.C.

Guerdon S. Holden, Plain Dealer Building, Cleveland, Ohio.

Earl Ingerson, Geophysical Laboratory, Washington, D.C.

William D. Johnston, Jr., U. S. Geological Survey, Washington, D.C.

Alfred W. Jolliffe, Canada Geological Survey, Ottawa, Ontario, Canada.

Joe W. Peoples, Wesleyan University, Middletown, Connecticut.

Alonzo W. Quinn, Brown University, Providence, Rhode Island.

Terence T. Quirke, University of Illinois, Urbana, Illinois.

Max Reinhard, University Museum, Basel, Switzerland.

Ralph L. Rutherford, University of Alberta, Edmonton, Alberta, Canada.

John T. Stark, Northwestern University, Evanston, Illinois.

Wladimir J. Vernadsky, Moscow, U.S.S.R.

## REPORT OF THE SECRETARY FOR 1939

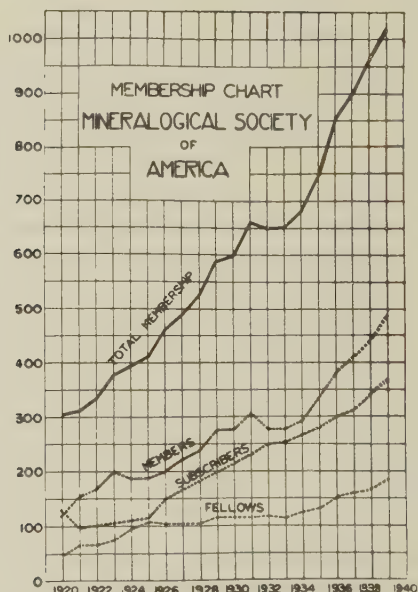
*To the Council, Fellows and Members:*

## MEMBERSHIP STATISTICS

	1938	1939
Correspondents	8	8
Fellows	171	184
Members	441	484
Subscribers	339	366
	<hr/> 959	<hr/> 1042

## GAIN AND LOSS FOR 1939

	Gain	Loss
Correspondents	0	0
Fellows	18	5
Members	103	60
Subscribers	53	26
	<hr/> 174	<hr/> 91



During 1939, the Mineralogical Society of America has made a net gain of 83 in membership, or approximately  $8\frac{1}{2}\%$  on the basis of the 1938 total. This is a greater increase than in either 1937 or 1938. Although there has been a gain in both members and subscribers, the greater gain, as in previous years, has been in members.

At the present time, the society has fellows and members in 46 states, and 34 foreign countries. The membership as a whole, including subscribers, passed the 1000 mark this past year as shown by the accompanying chart.

Respectfully submitted,

PAUL F. KERR, *Secretary*



## REPORT OF THE EDITOR FOR 1939

*To the Council, Fellows and Members of the Mineralogical Society of America:*

*The American Mineralogist* has experienced in 1939 what might be called a normal year. Without the benefits of a special issue which on numerous occasions in the past has substantially increased our total pagination, we can report nevertheless a satisfactory showing for the current year.

Volume 24 contained 810 pages exclusive of index. Nearly 85% of the space of the Journal was devoted to leading articles, which this year numbered 66. While a few of these major contributions were somewhat long, the average length was only  $10\frac{1}{2}$  printed pages. It may be of interest to note that in the classification of these 66 papers in the various fields covered by our Journal, petrography leads the list and is represented by 17 articles, followed by descriptive mineralogy, structural crystallography and chemical mineralogy (Table 1). If to these main articles we add 18 shorter papers that were accepted, we attain a total of 84 published manuscripts for the calendar year. These contributions were received from 93 contributors associated with 48 different Universities, research bureaus and technical laboratories.

The Journal always welcomes descriptions of new mineral species and during the past year six new minerals were recorded: teepelite, gratonite, overite, goldschmidtine, salesite and shortite.

The somewhat cosmopolitan character of the Society's journal has been maintained during 1939 by virtue of 10 papers received from beyond our own borders. These include 6 from Canada, 2 from the Czechoprotectorate, and one each from England and Venezuela.

We have maintained our usual liberal policy in regard to free reprints to authors and acceptance of manuscripts containing numerous illustrations. While the cost of engravings has become an important item in our monthly budget, many articles cannot be presented adequately without diagrams and photographs. In the present volume, for example, 372 illustrations have served to aid the reader to a better understanding of the topics discussed. However, our funds are limited and it is suggested that authors use discretion by restricting the number as far as possible and selecting only those that are deemed absolutely necessary and will reproduce to best advantage.

The accompanying table of contents summarizes in detail the distribution of subject matter in volume 24.

TABLE 1. DISTRIBUTION OF SUBJECT MATTER IN VOLUME 24

<i>Subjects</i>	<i>Articles</i>	<i>Pages</i>	<i>Per Cent of Total</i>
Leading articles*			
Descriptive mineralogy	16		
Chemical mineralogy	8		
Structural crystallography	9		
Mineralography	2		
Geometrical Crystallography	6		
Petrography	17		
Optical mineralogy	4		
Miscellaneous	4		
	66	686	84.7
Short articles	18	43½	15.3
Proceedings of societies	22	65½	
Notes and news	13	1½	
Abstracts of new mineral names	26	7½	
Book reviews	8	6½	
Total entries	153	810	100.0
Illustrations	372		
Index, covers, advertisements		114	
Total		924	

\* (Average length of leading articles, 10.4 printed pages)

Respectfully submitted,

WALTER F. HUNT, *Editor*

#### REPORT OF THE TREASURER FOR 1939

*To the Council of the Mineralogical Society of America:*

Your Treasurer submits herewith his annual report for the year beginning December 1, 1938, and ending November 30, 1939.

#### RECEIPTS

Cash on hand December 1, 1938.....	\$2,305.54
Dues and subscriptions.....	2,999.47
Advertisements.....	465.90
Sale of back numbers.....	579.17
Authors' charges on separates.....	749.76
Interest on endowment (bonds).....	2,337.00
Interest on endowment (stocks).....	120.00
Sale of 20-volume index.....	45.12
Geological Society of America grant for 1939.....	1,500.00
Harvard contribution, November 1938 issue.....	468.15
Partial payments (1939) on principal of Trenton Mortgage Service Company's preferred stock.....	340.82
Contribution to Dana Fund.....	10.00
Payment received in error.....	6.60

**\$11,927.53**

DISBURSEMENTS

Printing and distribution of the Journal (12 issues).....	\$5,973.98
Printing and distribution of separates.....	868.92
To the Editor, Secretary, and Treasurer.....	970.00
Postage.....	219.68
Printing.....	123.99
Stationery.....	89.20
Clerical help.....	340.06
Committee expenses.....	9.12
Safety deposit box.....	8.25
Bank collecting charges.....	4.94
Telegrams.....	2.60
Refund on dues.....	5.50
Check returned.....	3.00
Balance of payment, Roebling Medal, 1938.....	5.10
Transfer of contribution to Dana Fund.....	10.00
Refund of payment received in error.....	6.60
Re-investment of endowment money.....	1,066.64
	<hr/>
	\$9,707.58
Cash balance November 30, 1939.....	2,219.95
	<hr/>
	\$11,927.53

The endowment funds of the Society as of November 30, 1939, consist of the following securities:

4 \$100 bonds, Great Northern Railway Co., Genl. mtg. 5½%, due January 1, 1942.....	\$ 400.00
2 \$500 bonds, Union Pacific Railroad Co., First lien and ref. mtg., 4%, due June 1, 2003.....	1,000.00
45 \$1,000 bonds, City and County of Honolulu, Territory of Hawaii, Water Works, 5%, due April 15, 1954.....	45,000.00
37-514/1000 shares, Trenton Mortgage Service Co., Trenton, N.J., preferred stock.....	3,249.90
5 shares, American Telephone and Telegraph Co., common stock.....	620.57*
5 shares, Public Service of New Jersey, 8% preferred stock.....	702.00*
5 shares, United States Steel, 7% preferred stock.....	502.45*
10 shares, Consolidated Edison, 5% preferred stock.....	1,066.64*
Cash <sup>a</sup> from the Trenton Mortgage Service Company.....	340.82
	<hr/>
	\$52,882.38

<sup>a</sup> Carried temporarily in the current account of the Society.

\* Purchase price.

Respectfully submitted,

WALDEMAR T. SCHALLER, *Treasurer*



## DANA FUND

Statement of the Special Dana Fund of the Mineralogical Society of America, initiated by Prof. E. S. Dana, and since his death cared for by the Treasurer. Disbursement made to the daughter of Prof. F. Berwerth, in Vienna.

## RECEIPTS

Available balance, November 30, 1938 . . . . .	\$968.92	
Interest . . . . .	17.88	
Contribution . . . . .	10.00	
		<hr/>
		\$996.80

## DISBURSEMENTS

Disbursed . . . . .	\$180.00	
Available balance, November 30, 1939 . . . . .	816.80	
		<hr/>
		\$996.80

Respectfully submitted,  
WALDEMAR T. SCHALLER, *Treasurer*

## REPORT OF THE AUDITING COMMITTEE

*To the President of the Mineralogical Society of America:*

The Auditing Committee has examined and verified the accounts and report of the Treasurer of the Mineralogical Society of America, for the fiscal year ending November 30, 1939. The securities listed in the Treasurer's report, with all future coupons on the coupon bonds attached, are in the safety deposit box at the American Security and Trust Company of Washington, D. C.

Respectfully submitted,  
JOHN G. FAIRCHILD, *Chairman*  
JOSEPH J. FAHEY  
JEWELL J. GLASS

## ANNUAL LUNCHEON, MINERALOGICAL SOCIETY OF AMERICA

The annual luncheon of the Mineralogical Society of America was held in the Hotel Nicollet, Minneapolis, Minnesota, at 12 noon on Thursday, December 28th, 76 members and friends of the society being in attendance. Dr. Ellis Thomson of the University of Toronto, past president of the society, presided and served as toastmaster during a short, informal, and most enjoyable program.

## PRESENTATION OF PAPERS

## THE PEGMATITES OF THE KEYSTONE AREA\*

CONSTANTIN N. AFSOURI

Detailed mapping of the Hugo, Peerless, Dan Patch, Bob Ingersoll and lesser pegmatites in the Keystone area, supported by critical study of the relations between their minerals and the country rock lead the writer to conclude that:

(1) Some criteria interpreted as favoring replacement need revision, having been used to support two diametrically opposed views; examples are euhedral crystals.

(2) Even a well-established criterion should be employed in the light of spatial and structural relations.

(3) While replacement did take place, its role is over-emphasized. The spodumene "logs" at the Etta mine are not products of replacement.

(4) The common belief that muscovite and muscovite books are replacement products is not supported by the field evidence cited by advocates of replacement. Muscovite forms less than 1% in common pegmatites. The contention that mica occurs at the contact is not strictly correct: mica books are frequently far from a major contact. Not all pegmatites bear mica. The almost constant association of schist xenoliths with an aureole of muscovite books suggests a genetic relationship. The mica probably resulted from the assimilation of the schist by the pegmatitic magma.

(5) Structure and mode of emplacement of pegmatites has not been stressed lately. Pegmatites distend the country rock, or stope their way through, or both, as suggested by xenoliths and the sharp transgression of schistosity by some contacts.

(6) The sequence of mineral paragenesis described by Landes (1928) is revised.

(7) A single mapping of a pegmatite is insufficient. Repeated visits and mapping, concurrent with the progress of mining, are essential to uncover significant data, otherwise irretrievably lost.

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\* Presented through the Society of Economic Geologists.

## STILPNOMELANE, NONTRONITE, AND HALLOYSITE FROM NORTHERN MICHIGAN

VINCENT L. AYRES

Stilpnomelane, nontronite, and halloysite have not heretofore been reported from the Michigan iron mining districts.

The first of these, stilpnomelane, occurs as a *contact* mineral where granite pegmatite has intruded ferruginous slate at Crystal Falls. Notable in the complete analysis is an abnormally high content of ferric iron together with appreciable manganese. The arc spectrograph proves the absence of potash. Refractive indices are:  $\alpha = 1.634$ ,  $\beta$  &  $\gamma = 1.730$ .

The nontronite superficially resembles chrysocolla. It occurs abundantly with halloysite and limonite lining cracks in a shatter zone at the New Richmond pit east of Palmer on the Marquette Range, and also in a seam in post-Huronian granite five and one-half miles to the west. Nontronite also is to be found at scattered localities on the Menominee and Gogebic Ranges.

The halloysite may not be hydrothermal, but at least it is another example of alumina transported in solution.

STRUCTURAL CONTROL IN EUROPEAN LEAD-ZINC ORES  
OF THE MISSISSIPPI VALLEY TYPE\*

CHARLES H. BEHRE, JR.

This discussion is limited to tectonic, non-mineralogic features, observed during nine months of field work, supplemented with observations by others.

The flat-lying strata of German and Polish Silesia and those of the north Moroccan deposits (Oujda, Toussit) show ore following bedding-partings near normal faults; absence

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\* Presented through the Geological Society of America.

of obvious trunk channels suggests the Upper Mississippi Valley and Tri-State relationships in the United States. The ores near Alston (northern England) and Djalta (Tunisia) are similar. Somewhat similar also are those of Derbyshire (Mill Close mine), but here mineralized fissures are well exposed.

At Aachen and near-by Limburg (Holland) and Moresnet (Belgium) mineralized large faults, from which the ore spreads outward, are well-marked and bedding plane openings are still prominent. But in Wales (Halkyn) and the middle Rhine valley (e.g., Ems) fault openings play the only important role.

At the opposite extreme from the Silesian deposits are replacements and fissure fillings in Alpine limestones at Mezica (Yugoslavia), Cave di Predil (Italy), and Bleiberg (Austria). These show replacements confined to the neighborhood of complex faults, largely thrusts, yet mineralogy and paragenesis are essentially as in the cases first cited.

Summarizing, widespread studies yield transition types between (1) deposits in highly strained rocks and (2) deposits in almost undeformed sediments, in which the direction of mineralization is still actively debated, both here and abroad. The tectonic relations of the less deformed types can therefore scarcely be adduced as arguments against hydrothermal origin.

#### CLASSIFICATION OF THE NATIVE ELEMENTS, SULPHIDES, AND SULPHO-SALTS

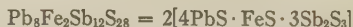
HARRY BERMAN

The classification is that to be followed in the seventh edition of Dana's "*System of Mineralogy*." Native elements are arranged beginning with the gold group. Sulphides and sulpho-salts are arranged according to a decreasing  $A:X$  ratio, where  $A$  represents the metallic and  $X$  the nonmetallic elements. Groups are based on crystallographic and chemical similarities.

#### STRUCTURAL CRYSTALLOGRAPHY AND COMPOSITION OF JAMESONITE

L. G. BERRY

Jamesonite with basal cleavage, from Cornwall (type locality), Huanuni, Bolivia, and the Itos Mine near San Felipe de Oruro, Bolivia, gives identical  $x$ -ray powder photographs. Rotation and Weissenberg photographs of a needle-like crystal from the Itos Mine show monoclinic symmetry; space group  $P2_1/a$ ;  $a_0$   $15.68 \pm 0.05$ ,  $b_0$   $19.01 \pm 0.05$ ,  $c_0$   $4.03 \pm 0.01 \text{ \AA}$ ;  $\beta = 91^\circ 48' \pm 30'$ ; twinning on (100). The available good analyses on jamesonite with basal cleavage give the cell content:



Specific gravity 5.67 (calc.), 5.63 (meas.). The structural lattice is simply related to the geometrical elements of Slavík (1914); the cell content confirms the empirical formula derived by Loczka (1908) and reached independently by Schaller (1911).

#### THE STRUCTURAL SCHEME OF ATTAPULGITE

W. F. BRADLEY

The tendency of clays to form aggregates which exhibit preferred orientation can often be made use of to provide  $x$ -ray diffraction data not apparent in powder diffraction diagrams. Flaky aggregates of attapulgite formed by sedimentation from a suspension consist of fibrous particles whose fibre axes lie in the plane of the flakes. A series of patterns made with radiation incident at various inclinations to such flakes show fairly well developed arcs for reflections of the type  $hk0$  (the fibre axis being  $c$ ). The  $c$ -axis periodicity is about  $5.2 \text{ \AA}$ . Too little data are available for a complete solution of the structure, but a projection on to 001 of an idealized structural scheme consistent with the observed  $hk0$  interferences is proposed.

Attapulgit is probably monoclinic, probable space group  $C_{2h}^2-C2/m$  with  $a_0 \sin \beta = 12.9 \text{ \AA}$ ,  $b_0 = 18 \text{ \AA}$ . The ideal formula, derived from that of the amphiboles, can be written  $(OH)_4(OH)_2Mg_5Si_8O_{20} \cdot 4H_2O$ , there being two molecules to the unit cell. Partial replacement of  $Mg^{++}$  by  $Al^{+++}$  on a three for two basis is extensive but such replacement can probably not be complete. The structure is made up of amphibole-like chains running parallel to  $c$  (at  $00Z$  and  $22^{11}Z$ ) with each chain linked through oxygen at its corners to four neighboring chains. Interstitial chains of water molecules also parallel the  $c$ -axis and separate the amphibole chains.

The scheme is consistent with the fibrous nature of the material its clay habit, its optical properties, and its dehydration characteristics.

#### AN X-RAY INVESTIGATION OF THE SOLID PHASES OF THE SYSTEM $Cu_2S$ - $CuS$

NEWTON W. BUEGER

A systematic x-ray study of the solid phases of the system  $Cu_2S$ - $CuS$  has been made. A special camera was designed to make x-ray photographs of powder samples at high temperatures. This camera allows the specimen to remain heated continuously, and the heat treatment can be controlled as in a furnace. The resulting phase diagram shows that the system contains three compounds and six phases. The compounds are:

chalcocite, ideally  $Cu_2S$   
 digenite, ideally  $4Cu_2S \cdot CuS = Cu_9S_5$   
 covellite,  $CuS$

Chalcocite undergoes three transformations, and none of the high temperature phases is cubic up to at least  $250^\circ C$ . The revised inversion scheme is:

above  $105^\circ C$ ., non-isometric completely disordered basic structure  
 $78^\circ C$ . to  $105^\circ C$ ., non-isometric partially disordered basic structure  
 $52^\circ C$ . to  $78^\circ C$ ., non-isometric ordered basic structure  
 below  $52^\circ C$ ., orthorhombic superstructure.

The superstructure phase is capable of dissolving up to 8 atomic per cent  $CuS$  while the ordered basic structure can dissolve only 2 atomic per cent  $CuS$ . The experimental evidence indicates a hitherto unrecognized compound  $Cu_9S_5$ , whose powder pattern is essentially identical with that of the discredited mineral digenite, to which the formula  $2Cu_2S \cdot CuS = Cu_9S_5$  had been assigned. Below approximately  $47^\circ C$ . digenite has the ideal composition  $Cu_9S_5$ , but above this temperature it takes increasing amounts of either  $Cu_2S$  or  $CuS$  into its composition. Evidently digenite has been regarded as the phase of chalcocite stable above  $91^\circ C$ . Certain regions of the phase diagram of this system may be applied to problems of geologic thermometry, providing that proper criteria are recognized.

#### THE BARTLETT METEORITE, BELL COUNTY, TEXAS

FRED M. BULLARD

This nickel-iron meteorite, weighing 8.59 kilograms, was ploughed up in a field about 5 miles west of the town of Bartlett in Bell County, Texas, about 4 years ago. A polished and etched section showed well developed Widmanstätten figures. The meteorite is a medium octahedrite consisting essentially of grouped kamacite plates with narrow borders of taenite and smaller amounts of plessite, schreibersite, and troilite. A chemical analysis gave 90.41% iron, 8.88% nickel, and small amounts of cobalt and phosphorus. A spectrographic analysis showed small quantities of copper, silicon, and germanium in addition to the elements reported in the chemical analysis.



## THE CONCEPT OF UNIQUE DIAMETERS IN CRYSTALLOGRAPHY

J. DABNEY BURFOOT, JR.

A unique diameter is a line, or diameter, unlike any other in the crystal. All parallel lines are the same line crystallographically. All properties, physical, chemical, and crystallographic, along a unique diameter are different from those along any other line in the crystal.

Several criteria based on physical and chemical properties, the groupings of faces and angles between faces, and the dimensions of crystals may be used to recognize unique diameters. Likewise, laws controlling their distribution in crystals and their relations to the various elements of symmetry may be formulated. Since their arrangement in each crystal system is different from that in any other, except that the tetragonal and hexagonal are alike, unique and like diameters may be used to define the six crystal systems independent of symmetry and axes of reference, and the selection and orientation of axes of reference may be based on them.

Some of the applications and relationships of this concept are: (1) the assignment of crystals to systems without the use of symmetry or hypothetical axes of reference; (2) the easy selection of axes of reference; (3) the determination of the crystal system to which a mineral belongs from its cleavage fragment; (4) a clarification of some of the relationships and conditions observed in optical mineralogy; and (5) the simplification of the teaching of crystallography, especially in short courses where it is desirable to present only the commoner forms and not to discuss classes.

This concept elevates systems to a rank of prime importance in crystallography based on independent properties and not on hypothetical axes of reference or groupings of classes.

## PETROGRAPHY OF TWO IOWA LOESS MATERIALS

F. LEICESTER CUTHBERT

Two samples of loess material, selected by the Iowa State Highway Commission as being significant in highway construction, were investigated by several methods with the purpose of determining their mineralogical constitution. Although the materials are nearly similar as far as standardized highway laboratory tests are concerned, one affords a stable highway foundation while the other gives considerable difficulty, causing the slab to buckle and dip. Field examination revealed that the materials differed in their relation to a heavy gumbotil; one being located immediately above, and the other about ten feet above the gumbotil. The samples were fractionated by sedimentation and by a supercentrifuge. Chemical, x-ray, optical, and base-exchange studies were made on each of the colloidal separates obtained. The results show that one of the samples contains as its principal clay mineral, montmorillonite, while the other contains mixtures of kaolinite and illite. Evidence points to the conclusion that highway engineers must take into consideration both the geological positions of the materials to be used in subgrades and their clay mineral content.

## ELEMENTARY DERIVATION OF THE 230 SPACE GROUPS

J. D. H. DONNAY

Elementary derivations of the 32 crystal classes and 14 lattices are known. The extinction criteria of the lattice modes can be established by simple considerations (Friedel's *Leçons*, 1926); the same method holds for deriving the extinction criteria of the various kinds of glide-planes and screw-axes. From these criteria, the different types of zonal distribution (described elsewhere)<sup>1</sup> are graphically derived (with the aid of the reciprocal

<sup>1</sup> Donnay, J. D. H., Le développement des zones cristallines: *Ann. Soc. géol. de Belgique*, 61, B 260-287 (1938).

lattice): *simple zones*, either with unit-face dominant or with dominant shifted, and *double zones*, in which the dominant is always the unit-face. A simple search of all the permissible combinations of such zone types for each lattice mode in each crystal system leads to the 97 *morphological aspects*. Which space-group (or space-groups), in the several classes, correspond to any one aspect then becomes immediately apparent. The method naturally lends itself to the use of the international (Hermann-Mauguin) notation for space-groups, and leads to the appropriate symbols for all alternate crystal settings.

The morphological expression of the space-group symmetry is shown, by means of simple conventions, on a stereographic projection. This projection assumes further value as an unequivocal graphic representation of the *aspect* in a certain setting.

### SPECTROGRAPHIC STUDY OF CINNABAR

ROBERT M. DREYER

A quantitative spectrographic study of cinnabar from twenty quicksilver deposits has indicated the elemental content of quicksilver mineralizing solutions and the extent to which various impurities exist in solid solution in cinnabar. The study indicates that certain heavy metals are invariably associated with cinnabar ores (viz., iron, chromium, manganese, silver, copper, zinc, nickel, germanium, lead, and cobalt). Of these elements, certain are markedly differentially concentrated (presumably in solid solution) in the cinnabar—namely, copper, lead, cobalt, germanium, and silver. Such concentrations are found regardless of geological or geographical occurrence. The varying shades of cinnabar coloration are found to be independent of the elements differentially concentrated in the cinnabar.

### A NEW PROJECTION-PROTRACTOR

D. JEROME FISHER

This projection protractor is made for either the stereographic or gnomonic projections. It is designed for general use with these projections, rather than solely for crystallographic purposes. It should therefore appeal to the field and laboratory geologist. Besides the usual stereographic and gnomonic scales drawn to spheres of radii 5 and 2 centimeters, it embraces a meridional stereographic half-net and a centimeter scale. It may be used as an ordinary protractor, straight-edge, scale, and right-angle triangle. It is available as an 8×20 centimeter rectangle on colorless transparent cellulose acetate .025 inch thick.

### THE BINARY SYSTEM: $\text{NaAlSi}_3\text{O}_8$ - $\text{CaSiO}_3$

W. R. FOSTER

A study of the equilibrium relations of the binary system carnegieite, nephelite-pseudowollastonite, wollastonite has been made as part of an investigation of the ternary system carnegieite, nephelite-pseudowollastonite, wollastonite-albite. The liquidus and sub-liquidus relations, and their petrological significance, are discussed.

### EXSOLUTION GROWTHS OF ZINCITE IN MANGANOSITE

CLIFFORD FRONDEL

Manganosite crystals from Franklin, N. J., contain thin plates of zincite intergrown along octahedral planes. The two minerals are mutually oriented, with zincite {0001} [10 $\bar{1}$ 0] parallel to manganosite {111} [110]. This position of orientation marks an exact coincidence in crystal structure of the two minerals. The zincite apparently has exsolved from the manganosite.

## REDEFINITION OF TELLUROBISMUTHITE

CLIFFORD FRONDEL

Tellurobismuthite, long considered a variety of tetradymite, is a distinct species. Composition of unit cell  $\text{Bi}_2\text{Te}_3$ ; rhombohedral, with  $a_0 = 4.43 \text{ \AA}$  and  $\alpha = 57^\circ 11'$ ;  $G = 7.66$  (calc.), 7.65 (meas.); perfect cleavage {0001}. Ten localities are cited. Vandiesitte, a supposed telluride of Bi and Ag from Colorado, is shown to be a mixture of tellurobismuthite and hessite. X-ray powder data and polished section data are summarized for tellurobismuthite, tetradymite, gruenlingite, joseite and wehrlite.

## THE RADIOACTIVITY OF SEDIMENTARY ROCKS AND ASSOCIATED PETROLEUM\*

CLARK GOODMAN, K. G. BELL, AND W. L. WHITEHEAD

Determinations of the radioactivity of 21 sedimentary rocks and 7 associated crude oils have been made by the precision method developed by R. D. Evans (1). The specimens consisted of cuttings and cores from wells in the Bartlesville, Cromwell, Frio, Woodbine and Viola-Simpson formations. Considerable variability in radioactivity was found in the sandstones ( $1.4$  to  $0.19 \times 10^{-12}$  gms Ra/gm) and limestones ( $1.3$  to  $0.18 \times 10^{-12}$  gms Ra/gm). The radium content of limestones decreases with increasing purity. The shales were quite uniform ( $1.2$  to  $1.0 \times 10^{-12}$  gms Ra/gm). Apparently, discrete mineral particles in sandstone and impurities in limestone account for their occasional high radioactivity. The radon content of the crude oils ( $0.47$  to  $0.05 \times 10^{-12}$  curies/gm of oil) was in one sample 38 times, and averaged 10 times, the amount in equilibrium with the radium present. The results corroborate the inferences of former investigators that radon tends to concentrate in crude oils. Maximum radon content and maximum ratio of radon to radium were found in petroleum produced from a permeable, Oligocene (Frio) sandstone of high radioactivity. Cracking of hydrocarbons with generation of hydrogen has been proved by S. C. Lind (2) to result from bombardment with alpha rays. The amounts of radioactivity found in these crude oils are quantitatively sufficient to cause appreciable cracking by alpha radiation during geologic time. These reactions, together with subsequent hydrogenation, may account for important changes in petroleum. This hypothesis would also explain the presence of hydrogen in some natural gases. The hydrogen content of soil gases is suggested as a possible method of geophysical prospecting for oil fields.

(1) Evans, R. D., *Rev. Sci. Inst.*, **6**, 99-112 (1935).

(2) Lind, S. C., "The Chemical Effects of Alpha Particles and Electrons," Chemical Catalog Co. (1928).

\* Presented through the Society of Economic Geologists.

## TUNGSTEN ARCS\*

PAUL F. KERR

The tungsten deposits of the Cordillera of the United States define three belts for convenience designated as *tungsten arcs*: (1) extending from southern California to eastern Washington; (2) extending from southern Arizona to eastern Idaho; and (3) extending from Silverton, Colorado, to the Black Hills. More important tungsten localities along the arcs are:

*Western arc*—California: Atolia, Posey, Pine Creek, Tungsten Hills.

Nevada: Silver Dyke, Nightingale, Oreana, Mill City.

Oregon: Baker-Wallowa Mountain.

Washington: Germania.

\* Presented through the Geological Society of America.

*Central arc*—Arizona: Dragoon, Las Guijas, Boriána.

Nevada: Snake Range.

Idaho: Lemhi

*Eastern arc*—Colorado: San Juan, Boulder.

South Dakota: Black Hills.

The western arc is perhaps connected with later phases of Nevadian orogeny, the central and perhaps the eastern arcs with Laramide. In each district the mineralization shows a relationship to the trend of the respective arc and suggests influence of an underlying igneous source.

Deposits are apparently confined to areas of actual or proximate igneous activity. The immediate contact is frequently barren. Aplite and pegmatite dikes or quartz veins favor concentration evidently as conduits from magmatic sources. Conduit bodies frequently contain traces but rarely concentrations of tungsten minerals. Field examination with ultra-violet light evidences the connection between ore formation in a host rock, scheelite bearing aplitic conduits, and adjacent granitic intrusives.

Considerable deposits may consist chiefly of scheelite, wolframite, hübnerite or ferberite ores but the psilomelane or limonite type may prove to be important. Tungsten-bearing minerals occur in hot spring deposits, in quartz veins, in pegmatite dikes, in greisen zones and in contact metamorphic deposits. Ca-tungstate predominates in the western arc with the exception of Germania. Ca-, Fe-Mn-, and Mn-tungstates are important in the central arc. Fe-, Mn-, and Fe-Mn-tungstates are most abundant in the eastern arc.

#### FURTHER STUDIES ON THE VARIATION OF HARDNESS IN THE DIAMOND

EDWARD H. KRAUS AND CHESTER B. SLAWSON

Approximate hardness curves for certain crystal faces of the diamond are indicated, and the areas of optimum cutting and those which resist cutting are delimited.

#### THE GEOGRAPHIC CLASSIFICATION OF ANALYSES OF METAMORPHIC AND IGNEOUS ROCKS\*

EDWARD B. MATHEWS

The ambitious undertaking supported by grants from the Geological Society is now well advanced and it has been deemed advantageous to present to the Fellows of the Society something of the manner of procedure and the results obtained, and how the results may be serviceable before the undertaking is completed.

One of the largest published collections of chemical analyses of rocks is that in Professional Paper 99 which carried analyses published before 1913. This contains something over 9000 analyses. The present collection which is to be carried to 1940 already contains between 30,000–40,000 analyses grouped in single degree units. Since the sources are indicated this work may well serve as a series of bibliographies of small geographical units, and a geologist going into a new region may readily secure a clue to practically all the available literature sufficiently detailed to have analyses of rocks.

The method of classification, some of the difficulties encountered in securing the location of the samples analyzed and some suggested improvements which can be made by authors in the future will be discussed if time permits.

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\* Presented through the Geological Society of America.



## THE ISODIMORPHOUS SERIES, VARISCITE-METAVARISCITE

DUNCAN MCCONNELL

Through the use of  $x$ -ray methods the minerals starred have been referred definitely to an isodimorphous series.

Orthorhombic	Monoclinic ( $\beta \rightarrow 90^\circ$ )	Composition
*Variscite	Metavariscite	$\text{AlPO}_4 \cdot 2\text{H}_2\text{O}$
*Barrandite	—	$(\text{Al}, \text{Fe})\text{PO}_4 \cdot 2\text{H}_2\text{O}$
—	Vilateite	$(\text{Fe}, \text{Mn})\text{PO}_4 \cdot 2\text{H}_2\text{O}$
*Strengite	*Phosphosiderite	$\text{FePO}_4 \cdot 2\text{H}_2\text{O}$
*Scorodite	—	$\text{FeAsO}_4 \cdot 2\text{H}_2\text{O}$

The axial ratios, optical properties, etc., permit the classification of the substances for which  $x$ -ray data have not been obtained. A more complete investigation will probably reveal that several poorly known substances are to be associated with this series.

## DESCENT OF PLAGIOCLASE-RICH CORUNDUM BEARING PEGMATITES FROM DESILICATED GRANITE AT GLEN RIDDLE, PA.

ADOLPH E. MEIER

Two divergent opinions are held on the origin of albitites and plumasites (corundum-plagioclase bearing dikes). Du Toit, Gordon and Cobb favor a process of desilication of high silica pegmatites by reaction with basic wall rock. Larsen believes that they possess a hydrothermal mode of origin. Analogous types occurring as dikes or hydrothermal veins at Glen Riddle are rich in oligoclase where flanked by serpentinite (meta-pyroxenite), and rich in andesine, oligoclase and corundum where associated with narrow dikes of gabbro previously emplaced in pyroxenite.

On the basis of a recent study of relations between the local hornblende granite, meta-pyroxenite and gabbro<sup>1</sup> and of more detailed work on the granite now in progress, it is believed that desilication and hydrothermal replacement have both played a significant role in the formation of the plagioclase-rich dikes and of the corundum found in the types mentioned.

Sufficient data has been collected thus far in three typical exposures to show that in comparatively large masses of granite the magnesium content increases and the quartz content of the latter decreases from the center of the mass to the bordering meta-pyroxenite. Where granite stringers or tongues narrow down to ten feet or less the quartz content is reduced to two per cent.

The conclusions to be drawn are that a process of desilication took place during an early stage of granitic intrusion as a direct result of assimilation of the invaded pyroxenite. As a result of this chemical conditioning the granitic exudates carried a high concentration of alkalis which filtered into the country rock, and produced veins analogous to plumasites by hydrothermal reaction with previously emplaced gabbro, and types analogous to albitites where pyroxenite alone was the host rock.

<sup>1</sup> Corundum in a dike at Glen Riddle, Pa: Tomlinson, W. H., *Am. Mineral.*, **24**, 339-343 (1939).

Association of harmotome and barium feldspar at Glen Riddle, Pa.: Meier, A. E., *Am. Mineral.*, **24**, 540-560 (1939).

## THE CRYSTALLOGRAPHY OF ULEXITE

JOSEPH MURDOCH

Measurable crystals of ulexite discovered at Kramer, California, show that the mineral is triclinic, with the following elements:

$a:b:c$	0.68553:1:0.51911	
$\alpha=90^{\circ}16'$	$\beta=109^{\circ}08'$	$\gamma=105^{\circ}07'$
$\rho_0:q_0:r_0$	0.78523:0.50804:1	
$\lambda=84^{\circ}20\frac{1}{2}'$	$\mu=70^{\circ}05\frac{1}{2}'$	$\nu=73^{\circ}53\frac{1}{2}'$
$\rho'_0=0.83514$	$q'_0=0.54032$	
$\alpha'_0=0.34662$	$\gamma'_0=0.10483$	

The crystals occur as an irregular network of prismatic forms in a matrix of borax and clay. They are sometimes as much as five mm. long, though few terminated crystals are this size. In general the shape of the crystals is lath-like, with elongation 3–4 times the short dimension. The consistently broad face in the prism zone is (100), and other common faces here are (010) (110) and (110). (130) (350) (310) and (120) were also seen. Terminal faces, in order of frequency, are ( $\bar{1}\bar{1}$ 1) (0 $\bar{1}$ 1) (001) ( $\bar{1}$ 11) ( $\bar{1}$ 01), the form ( $\bar{1}\bar{1}$ 1) appearing on practically every crystal.

#### THE TERNARY SYSTEM AKERMANITE--GEHLENITE--PSEUDO-WOLLASTONITE

E. F. OSBORN AND J. F. SCHAIRER

Phase equilibrium studies on the ternary system with the melilite molecules akermanite and gehlenite and a simple pyroxene,  $\text{CaSiO}_3$ , have just been completed. Akermanite and gehlenite form a complete series of solid solutions, but no appreciable solid solution exists between  $\text{CaSiO}_3$  and either akermanite or gehlenite. There is no ternary eutectic, but a minimum at  $1302 \pm 2^{\circ}$  with two solid phases present—a melilite (solid solution of akermanite and gehlenite) and pseudo-wollastonite. For some mixtures in this system, as crystallization proceeds melilite crystals are first enriched in akermanite, then reverse and become enriched in gehlenite.

#### CUPROBISMUTITE—A MIXTURE

CHARLES PALACHE

Cuprobismutite is shown by a study of the type material to be a mixture of three minerals—emphletite, bismuthite, and chalcocopyrite. Crystals of the two first-named minerals were measured.

#### MICROLITE FROM TOPSHAM, MAINE

CHARLES PALACHE AND F. A. GONYER

An analysis and physical description is given of a new occurrence of microlite which had previously been mistaken for gahnite.

#### RAMMELSBERGITE AND PARARAMMELSBERGITE, DISTINCT ORTHORHOMBIC FORMS OF $\text{NiAs}_2$

M. A. PEACOCK

Rammelsbergite from Schneeberg, Saxony (type locality) and Eisleben, Thuringia, gives identical x-ray powder photographs. The specimen from Eisleben is compact, fibrous to lathy, tin-white, with bright narrow cleavage planes. The polished section is white, homogeneous, hard, strongly anisotropic. With the fibre axis vertical Weissenberg photographs give orthorhombic symmetry; holohedral space group  $Pmnn$ ;  $a_0$  3.53,  $b_0$  4.78,  $c_0$  5.78 Å. Twin plane (110); cleavage {110}. The unit cell contains  $\text{Ni}_2\text{As}_4$ .  $G$  7.06 (calc.), 6.9–7.158 (Dana). These structural data conform to the meagre geometrical data (Dürrfeld, 1911), and show the expected similarity to those of marcasite (Buerger, 1931).

Recently described materials provisionally named rammelsbergite (Peacock and Michener, 1939), from Cobalt, Ontario, and Elk Lake, Ontario, give identical x-ray powder photographs unlike those of from Schneeberg and Eisleben. The specimens are compact,

tin-white, with small bright cleavage areas. The polished sections are white, homogeneous, hard, strongly anisotropic. Analysis: Ni 28.1, Co 0.4, As 68.5, S 2.6=99.6. Weissenberg photographs give orthorhombic (or pseudo-orthorhombic) symmetry; apparent holohedral space group *Pbma*;  $a_0$  5.74,  $b_0$  5.81,  $c_0$  11.405 Å; twinning not observed; cleavage {001}. The unit cell contains  $\text{Ni}_8\text{As}_{16}$ .  $G$  7.24 (calc.); 7.12 (meas.). The Canadian mineral is thus a distinct species for which the name *pararammelsbergite* is proposed.

The cell-edges of rammelsbergite and pararammelsbergite are not simply related to the cube-edge of smaltite-chloanthite (Ofstedal, 1925), supposed to have the composition (Co, Ni) $\text{As}_2$ .

#### RECONNAISSANCE OF THE CONTACT METAMORPHISM OF THE KATAHDIN GRANITE

SHAILER S. PHILBRICK

The Katahdin granite, an intrusive some 60 miles long, in Piscataquis and Penobscot counties, Maine, has been found to have metamorphosed its country rock, a series of slates and thin interbedded quartzitic sandstones of varying composition, with the development of the hornfels and schist. Near the igneous contact considerable aplitic material has been injected in veinlets and pygmatic folding and brecciation have been produced in the hornfels. The reconnaissance has been confined to the southern and southwestern portions of the intrusive where a belt of metamorphics some 35 miles in length has been noted outcropping on several mountain ranges. The metamorphics are strikingly similar in general character to those found about 10 miles to the south in the three zoned aureole surrounding the Onawa pluton, a small body about 11 miles long. The greater size of the Katahdin granite, as far as can be determined at this time, seems not to have comparably influenced the degree or lateral extent of the metamorphism.

Keith has mapped a belt of Cambrian or Ordovician rocks along the boundaries of the Katahdin granite in the area under consideration and also surrounding the Onawa pluton. In the latter case the writer believes that these rocks are the common Silurian of central Maine metamorphosed by the Onawa pluton. Those bounding the Katahdin granite here may, or may not, be pre-Silurian but since their metamorphic character is attributed mainly to contact with the granite it is assumed, in the absence of paleontologic evidence to the contrary, that they are Silurian and the same age as the common slate series of central Maine.

#### THE BINARY SYSTEM: ALBITE ( $\text{NaAlSi}_3\text{O}_8$ )-SPHENE ( $\text{CaTiSiO}_6$ )

A. T. PRINCE

The liquidus curve of the binary system, albite-sphene, has been determined as part of an investigation of the ternary system, albite-anorthite-sphene. The character of the curve and its petrological significance are discussed.

#### THE CRYSTAL SYSTEM AND UNIT CELL OF ACANTHITE, $\text{Ag}_2\text{S}$

LEWIS S. RAMSDELL

Preliminary data obtained from twinned acanthite crystals by means of Weissenberg photographs indicate a monoclinic unit cell, with  $a=4.20$ ,  $b=6.93$ ,  $c=9.50$  Å, and  $\beta=55^\circ$

#### CRYSTALLOGRAPHY OF DOLEROPHANITE

W. E. RICHMOND AND C. W. WOLFE

Dolerophanite,  $\text{Cu}_2\text{SO}_4$ , from the type locality has been re-examined. An x-ray study establishes the validity of the Goldschmidt orientation. The mineral is figured in this position.

## ZONES, ZONE-BUNDLES, AND CRYSTAL SYSTEMS

AUSTIN F. ROGERS

Zones are not sufficiently emphasized in elementary work. The use of a linear projection combined with a front elevation provides a simple method of showing the relation between face-indices and zone-indices.

All the possible zones of crystals are included under four types: clinogonal, orthogonal, hexagonal, and tetragonal, which are defined in terms of the interfacial angles that remain constant with a change of temperature.

A zone-bundle is a series of zones with one face in common and may be defined by its interzonal angles. Six kinds of zone-bundles are recognized: tetragonal, hexagonal, orthogonal of two kinds, and clinogonal of two kinds.

Zones furnish a simple, accurate method of defining crystal systems:

Triclinic: All zones are clinogonal.

Monoclinic: A symmetry direction (a symmetry axis or a line normal to a symmetry plane) is a clinogonal zone-axis.

Orthorhombic: Three orthogonal zones at right angles to each other.

Tetragonal: A single tetragonal zone.

Hexagonal: A single hexagonal zone.

Isometric: Three tetragonal zones and four hexagonal zones.

All crystals of a given crystal system have the same kind of normal zone-pattern, which may be defined as the complex of nine zones with the simplest indices or 13 zones if four axes of reference are used.

Since the 12 symmetry classes with a single hexagonal zone all have the same kind of normal zone-pattern, there are six crystal systems and not seven.

## THE RARER METALLIC CONSTITUENTS OF SOME AMERICAN IGNEOUS ROCKS

E. B. SANDELL AND S. S. GOLDBICH

This paper is a preliminary report of an investigation of the less abundant heavy metals in igneous rocks. Copper, lead, zinc, cobalt, nickel, and molybdenum were determined in 31 samples using semi-micro-chemical methods. The analyzed samples represent three igneous areas in central United States and are distributed as follows: from the Llano (Central Mineral) region of Texas, 7; from the St. Francois Mountains of Missouri, 7; from central and northern Minnesota, 17. In addition cobalt and nickel determinations were made on 19 samples of the Keweenaw flows from the Michigan copper district. The distribution of cobalt and nickel in the Kearsarge and in the Greenstone flows is discussed and correlated with Broderick's findings for copper and for the major rock constituents. The data are presented in tables and in a series of diagrams.

## A PROBABLY NEW PHOSPHATE-SULPHATE OF ALUMINUM FROM UTAH

WALDEMAR T. SCHALLER

A scaly white mineral, like alunogen in appearance and in its properties, was collected in the Tintic Standard mine, Dividend, Utah, along with many other secondary sulphates. The mineral, intimately associated with halotrichite, siderotile, and szomolnokite, is readily soluble in cold water from which solution when warmed a curdy white precipitate forms. On cooling, the precipitate disappears, the solution becoming clear again.

Analyses of two different samples yielded the same formula,  $2\text{Al}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot \text{P}_2\text{O}_5 \cdot 24\text{H}_2\text{O}$  which might be interpreted as a phosphorian alunogen, with one-third of the sulphate replaced by phosphate on the basis of considering  $[\text{SO}_4]$  and  $[\text{HPO}_4]$  as equivalent, as follows:



Alunogen	$\text{Al}_2(\text{SO}_4)_3 \cdot 16\text{H}_2\text{O}$	or $2\text{Al}_2\text{O}_3 \cdot 6\text{SO}_3 \cdot 32\text{H}_2\text{O}$
Phosphorian alunogen	$\text{Al}_2(\text{SO}_4)_2(\text{HPO}_4) \cdot 16\text{H}_2\text{O}$	or $2\text{Al}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot \text{P}_2\text{O}_5 \cdot 33\text{H}_2\text{O}$
Mineral	$\text{Al}_2(\text{SO}_4)_2(\text{HPO}_4) \cdot 11\frac{1}{2}\text{H}_2\text{O}$	or $2\text{Al}_2\text{O}_3 \cdot 4\text{SO}_3 \cdot \text{P}_2\text{O}_5 \cdot 24\text{H}_2\text{O}$

The mineral however contains less total water than a phosphorian alunogen, the ratio of  $\text{P}_2\text{O}_5$  to  $\text{SO}_3$  is definite (1:4), two different samples have the same composition, and most important, the mineral loses no water at  $105^\circ$  whereas alunogen loses 30 per cent or  $\frac{2}{3}$  of its total water at  $105^\circ$ . The mineral therefore seems to be a new species and not merely a variety of alunogen.

#### A METHOD FOR MAKING ACCURATE DRAWINGS OF CRYSTALS

WALDEMAR T. SCHALLER

Accurate crystal drawings may be made by photographing a crystal in the positions corresponding to the orthographic and clinographic projections. The crystal is adjusted in polar position on the goniometer and its correct position before the camera determined by various means. The photographs are enlarged to the proper size and the lengths of the intersection edges measured and transferred to the drawing, or they may be inked in on the enlargement and the crystal drawing traced off. Illustrated by examples.

#### LARGE SANIDINE CRYSTALS FROM UTAH

BRONSON STRINGHAM AND NORMAN C. WILLIAMS

Sanidine is often present in small monzonite intrusives of the Stockton-Tooele area of the Oquirrh Mountains, Utah. Two localities are of special interest because of the large size of the crystals and the ease with which they are separated from the parent rock. One mile south of Tooele in a small sill, sanidine crystals averaging three centimeters in length are easily procured. These crystals, grayish in color, exhibit faces conventional to orthoclase which is elongated parallel to  $a$ . Carlsbad twins are abundant and of unusual shape since the elongation of  $a$  is not sacrificed for elongation parallel to the prism. The gray color is due chiefly to inclusions consisting of calcite and small andesine crystals. The latter are often grouped in rows parallel to the growth lines of the host.

The second occurrence has been exposed by a water development tunnel in Pine Canyon north of Tooele. Large single crystals elongated parallel to  $a$ , and Carlsbad twins are abundant. They are gray in color and average eight centimeters in length with some reaching eleven centimeters. Although most crystals exhibit excellent forms, many are rounded due to resorption.

#### THE MORPHOLOGY OF COLUMBITE CRYSTALS

E. D. TAYLOR

By the morphological method of Donnay (1938), the space-group of columbite ( $\text{Fe Mn}$ ) ( $\text{Nb, Ta}$ ) $_2\text{O}_6$  is found to be  $Pman$ , in a new setting ( $a:b:c=0.4023:1:0.3580$ ) chosen so as to comply with the convention  $c < a < b$ . (Transformations: Taylor to Dana =  $010/300/003$ . Taylor to Sturdivant =  $001/010/100$ .) According to  $x$ -ray results (Sturdivant, 1930; confirmed by Peacock, 1939, unpublished), the space-group is  $Pcan$  (in the same setting). The conflict lies in the interpretation of the zone  $[100]$ : the morphology indicates  $(100)$  to be a mirror plane of symmetry, whereas  $x$ -rays unquestionably show it to be a  $c$  glide-plane. This is the first clear case of disagreement between the morphological and the structural results.

Although the available data concerning the faces  $(0kl)$  are scarce, they cannot be reconciled with a  $c$  glide-plane at all. That the structural arrangement might simulate a

mirror plane where a glide-plane actually exists is a plausible hypothesis which, however, cannot be substantiated at present.

As to the prediction of relative form importances, the classical Law of Bravais does not agree with the observed facts as well as the generalized law (Donnay-Harker, 1937) which, although not perfect, is decidedly better.

#### SLIDES SHOWING MINERAL ASSOCIATIONS OF CORUNDUM

W. HAROLD TOMLINSON

Three slides showing association of corundum in ultra-basic rocks.

Three slides showing association of corundum in syenites.

#### THE RELATIONSHIP BETWEEN THE CRYSTAL STRUCTURES OF THE GOLD-SILVER TELLURIDE MINERALS, SYLVANITE, KRENNERITE, AND CALAVERITE

GEORGE TUNELL

The crystal structures of the gold-silver telluride minerals, sylvanite, krennerite, and calaverite, are fundamentally related, although they crystallize in three different space-groups. In all three minerals pairs of tellurium atoms occur between metal atoms (gold or silver) along a set of parallel lines. The coordination is octahedral in all three minerals, but the nearest neighbors of a tellurium atom are in some cases three metal atoms and three telluriums, in others one metal and five telluriums, and finally in others five metal atoms and one tellurium; the nearest neighbors of each metal atom are in all cases six telluriums. New chemical analyses\* of krennerite and new pycnometric determinations of its density have been carried out on pure faceted crystals identified by measurement on the two-circle reflection goniometer in order to clear up uncertainties in the literature concerning these points.

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\* The chemical analyses were made by K. J. Murata in the U. S. Geological Survey.

#### CONTACT METAMORPHISM AT RYE PATCH, NEVADA

CHARLES J. VITALIANO

The area under discussion is situated in the west central part of the Humboldt Range.

Westward dipping sediments occur, consisting largely of Triassic (?) limestone interbedded with an occasional thin layer of a more shaly nature. These sediments have been intruded by two different types of igneous rocks. The earlier intrusive is of a granitic nature. It occurs as a small, irregular intrusive, sill-like in part, probably connected in depth with the Rocky Canyon intrusive which occurs farther south in the Humboldt Range. The second intrusive type is a porphyry of a basic nature occurring in dikes which cut across the bedding of the limestone.

Both types of intrusives are surrounded by an aureole of contact metamorphism. In addition, a long narrow area of contact metamorphism extends northward a considerable distance from the granitic intrusive. The changes produced in the sediments range from the recrystallization of the limestone to the development of typical contact silicates. The area has been mapped in detail in order to establish the areal distribution of metamorphism with relation to the intrusive. Microscopic studies have been made to establish the sequence of mineralization and selectivity of metamorphism for certain strata.

## GEM CORDIERITE FROM THE GREAT SLAVE LAKE AREA, N. W. T. CANADA

ROBERT E. FOLINSBEE

Transparent cordierite, pleochroic from an intense blue to clear yellow, occurs north of Great Slave Lake in garnet sillimanite gneiss and associated lens-like pegmatitic injections. Single prismatic crystals attain a size of 4 by 2 by 2 inches. These crystals are fractured but yield many fragments of gem size and quality.

New complete chemical analyses of the garnet and of the cordierite are presented. An endeavor is made to establish a correlation in the chemical composition of these minerals and to relate the optical and physical properties of each with their chemical composition. An unusual type of lamellar twinning in the cordierite, resembling albite twinning in the plagioclase series, is noteworthy.

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Among those who were present at the scientific sessions of the Society were:

Adam, P. A. M.	Grim, R. E.	Parsons, W. H.
Alexander, H. S.	Grout, F. F.	Peacock, M. A.
Allen, V. T.	Gruner, J. W.	Philbrick, S. S.
Ayres, V. L.		Prince, A. T.
	Ham, W. E.	
Bateman, A.	Hurlbut, C. S.	Quinn, A.
Bennett, M. G.		Quirke, T. T.
Bergquist, S. G.	Johnson, C.	
Berman, H.	Johnston, W. D.	
Berry, L. G.		Ramsdell, L. S.
Bowen, N. L.	Keppel, D.	Rinn, H. W.
Bradley, W. F.	Kerr, P. F.	Robertson, H.
Bruce, E. L.	Koschmann, A. H.	Rogers, A. F.
Buddington, A. F.	Kraus, E. H.	Rowan, J. J.
Buerger, N. W.		Rutherford, R. L.
Bullard, F. M.		
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## MEXICO

Academia Nacional de Ciencias Antonio Alzate, Apartado 77-98, Mexico City, Mexico.  
Tobias Chavez, Biblioteca de la Universidad Nacional de Mexico, calle del Lic. Verdad  
No. 2, Mexico City, D. F., Mexico.

## NEW ZEALAND

Librarian, Otago University, Dunedin, New Zealand.  
Director, Geological Survey, 156, The Terrace, Wellington, C. I., New Zealand.

## NORWAY

Bruns, F., (Bokhandel) Trondheim, Norway.  
Geologisk Museums Bibliotek, Trondhjemsveien 23, Oslo, Norway.  
Library, Norge Geologiske Underskelse, Kronprinsens Gate 6, Oslo, Norway.

## POLAND

Gebethner and Wolff, Krakowskie Przedmiescie 15, Filja I w, Warsaw, Poland.  
Institut Geologique de l'Etat, n Ville, Warsaw, Poland.

## SWEDEN

Hoganas-Billesolms A/B, Biblioteket, Hoganas, Sweden.  
A. B. Gleerupska, Univ. Bokhandeln, Lund, Sweden.  
Kungl. Vetenskapskademiens Bibliotek, Stockholm, Sweden.  
Mineralogical Department, University of Stockholm, Drottninggatan 118, Stockholm,  
Sweden.  
Sveriges Geologiska Undersökning, Stockholm 50, Sweden.  
University of Upsala Library, Upsala, Sweden.

## SWITZERLAND

Librairie Centrale et Universitaire, Rue de la Paix, 1, Lausanne, Switzerland.  
Petrograph Institut. Tech Hochschule, Sonneggstrasse 5, Zurich, Switzerland.

## U.S.S.R.

Gozud Publ. Bib. Kazakhstan, Pr. Lenina 11, Alma Ata, KssR, U.S.S.R.  
Kazakstanskij Filial, Akademii Nauk, Ul. Vinogradova 18, Alma-Ate, U.S.S.R.  
Az Krasn. Industr. Institut, Im. Azizbekova, Fund, Bib. Ul. Narodov Vostoka 22, Baku,  
U.S.S.R.  
Nauchn. Biblioteke Gos. Universiteta, Dzerzhinskaja N. 2, Dnepropetrovsk, U.S.S.R.  
Nauch Tech Bib Dnepropetrov. Gorn. Inst. Ul. Kirova N. 1, Dnepropetrovsk, U.S.S.R.  
Geologicheskomu Upravle, Niju Kirgizskoj SSR, Sadovaja Ul. Dom N. 17, Frunze,  
U.S.S.R.  
Jakutskomu Geologicheskomu, Upravleniju, Ul. Chernyshevskogo 62, Jakutsk, U.S.S.R.  
Kaz Gorno Metallurg Inst, Prospekt, Lenina 79, Alma Ata, Kazakhstan, U.S.S.R.  
Biblioteke Urrainsk, Geologish, Tresta. Ul. Mikhijlichenko 5, Kiev, U.S.S.R.  
Gos. Biblioteke Wseukr. Akad. Nauk Ul. Korolenko No. 58 A, Kiev, U.S.S.R.  
Kol Skaja Baza, Akademii Nauk, Apatitovaja Gora, Murm. Okr. Kirovsk, U.S.S.R.

- Biblioteka Arkticheskogo Inst., Fontanka 34, Leningrad 104, U.S.S.R.  
 Centralnoj Geologicheskoy Biblioteka, Vasil Ostrov, Srednoj Prospektj D. 72-B, Leningrad, U.S.S.R.
- Cnilks NKMP RSFSR, V. O. 3, Linija D. 2A, Leningrad, U.S.S.R.  
 Biblioteka Akademii Nauk, Birgevaia Linija 1, Leningrad, U.S.S.R.  
 Glavnoi Biblioteka L.G.I., W.O. 21 Linija 2, Leningrad, U.S.S.R.  
 Institut Ogneuporov, V.O. Tuchkova Naberezhnaja 2, Leningrad 164, U.S.S.R.  
 Mekhanobr. Nauchno Tekhn. Biblioteka V.O. 21, Linija D. 8-A, Leningrad 26, U.S.S.R.  
 Nauchnaja Bib., Im. M. Gorjkogo Pri Len. Gos. Univ. Vas Ostr. Univ. Nab. 7/9, Leningrad, U.S.S.R.
- Sojuzn. Sljudjanoi Kombinat, Ul.S. Perovskoi, 16, Leningrad, U.S.S.R.  
 Vsegei, Byvsh In. T. Min. Syrja, Pyzhevskij Per 7, Moscow 17, U.S.S.R.  
 Bibliogr. Sektoru Gosud. Nautschn. Biblioteka NKTP, Mal. Bronnaja 4, Moscow 104, U.S.S.R.
- Fund. Biblioteka, Oon Akademii Nauk S.S.S.R., Uliza Frunze 11, Moscow 19, U.S.S.R.  
 Geological Museum Karpinsky, Bolshaya Kaluzskaya St., No. 24, Moscow, U.S.S.R.  
 Giredmet, Nauchn. Tekhn. Biblio. Zubovskaja Ul. 7/17, Moscow 21, U.S.S.R.  
 Glavogneupor, Pokrovskij Buljvar 14, Moscow, U.S.S.R.  
 Gl. Red. Gorno Topl. Literaturny, Pr. Valdimirova 4, Moscow, U.S.S.R.  
 Knizhnyi Otdel, Akademii Nauk U.S.S.R., Ul. Kropotkina 16, Moscow 34 U.S.S.R.  
 Moskovsky Geologo-Razvedotschny Institut, Biblioteka, Mokhovaja II, Moscow, U.S.S.R.
- Nautschnoj Biblioteka, Narkomtjazazhproma Delovoj Dvor, IV, Podjesd, Moscow, U.S.S.R.
- Nigrisoloto im Kosareva Biblioteka Worobjewi Gori 47 A, Moscow 133, U.S.S.R.  
 Pochtov. Jaschik, No. 642/0423, Glavn. Pochtat, Moscow, U.S.S.R.  
 Trest Solotoraswedka Nikoljskaja Ul Straropanskij, Per 1 5, Moscow 12, U.S.S.R.  
 Ilmenskij Zapovednik, Akademii Nauk Miass Tchelijabinskij, Obl. U.S.S.R.  
 Fundament, Biblioteka P.G.U., Zaimka Ul. Genkelja 1, Perm. U.S.S.R.  
 Akademisch Biblioteka, Rostovsk Gos. Universiteta Ul. Engelsa 64, Rostov, N. Donu, U.S.S.R.
- Nauch Bib. Pri, Sargosuniversitete, Universitetskaja Ul. D. 42, Saratov, U.S.S.R.  
 Biblioteka Sverdl. Cos Universiteta Im. Corjkogo, Ul. 8 Marta 62, Sverdlovsk, U.S.S.R.  
 Biblioteka Uraljskogo Nauchno Issledov. In Tuta Geolog. Rasve, Dok I. Issled Miner Syrja Uralgeomin Pervomajskaja 1, Sverdlovsk, U.S.S.R.
- Uralskij Filial Akademi Nauk, Ul. Malycheva 31/8, Sverdlovsk, U.S.S.R.  
 Uralskoje Geologicheskoje, Upravlenije Ul. Vainera N. 55, Sverdlovsk, U.S.S.R.  
 Biblioteka Sredneaziatskogo, Indus. Ins. Ta. Assakinskaja 16, Tashkent, U.S.S.R.  
 Nauch, Issled Otd. Geologich Upravlenija Gruz SSR, Lermontovskaja Ul. 10, Tbilisi, U.S.S.R.
- Voronezhsk Gos. Universitet, Fundament Biblioteka, Universitetsk. Ul., Voronezh, U.S.S.R.

## VENEZUELA

- Instituto de Geologia, Avenida San Martin, Caracas, Venezuela.  
 The Caribbean Petroleum Company, Geological Department, Apartado 19, Maracaibo, Venezuela.



# CONSTITUTION AND BY-LAWS OF THE MINERALOGICAL SOCIETY OF AMERICA

## CONSTITUTION

### *Article I. Name*

This Society shall be known as the Mineralogical Society of America.

### *Article II. Object*

The object of this Society shall be the advancement of mineralogy, crystallography, and allied sciences.

### *Article III. Officers*

*Section 1.* The officers of the Society shall be a president, a vice-president, a treasurer, a secretary, and an editor, who shall be elected annually. There shall be an executive council consisting of the above officers, the retiring president, and four fellows at large, to be elected for terms of four years each.

*Section 2.* The Council shall be empowered to elect from time to time as honorary officers or fellows of the Society persons of eminence in the field of mineralogy, or some closely allied science, who shall serve for life.

### *Article IV. Membership*

*Section 1.* The general membership of the Society shall be composed of fellows, members, and patrons. There may also be correspondents.

*Section 2.* Fellows shall be persons who have published results of research in mineralogy, crystallography, or allied sciences, and who upon nomination by the Council shall have been duly elected to fellowship in the Society.

*Section 3.* Members shall be persons not fellows who are engaged or interested in mineralogy, crystallography, or allied sciences.

*Section 4.* Patrons shall be persons who have bestowed important favors upon the Society. Election to patronship carries with it the rights and privileges of members.

*Section 5.* Fellows, members, and patrons shall be entitled to vote in the transaction of the regular business of the Society. Only fellows are eligible to office in the Society.

*Section 6.* Correspondents shall be persons distinguished for their attainments in mineralogy, crystallography, or allied sciences and not resident in North America.

### *Article V. Amendments*

This constitution shall be amended when the proposed amendment is favored by four-fifths of all the fellows voting upon it. A copy of the proposed amendment shall be published in the journal of the Society at least three months before the annual meeting. Voting shall be by mail ballot.

## AMENDMENTS TO THE CONSTITUTION

### *Article II. Object*

The object of this Society shall be the advancement of mineralogy, crystallography, *petrography*, and allied sciences.

### *Article IV. Membership*

*Section 2.* Fellows shall be persons who have published results of research on mineralogy, crystallography, *petrography*, or allied sciences, and who upon nomination by the Council shall have been duly elected to fellowship in the Society.

*Section 2.* Outstanding scientists of recognized scientific accomplishments in the field of mineralogy, crystallography, petrography, and allied sciences, who are members of other scientific societies in the field of geology, such as the Geological Society of America, Society of Economic Geologists, American Institute of Mining and Metallurgical Engineers, American Association of Petroleum Geologists, and other similar scientific societies, may be nominated for *Fellowship* in the Society upon recommendation of the Council.

*Section 4.* Patrons shall be persons who have bestowed important favors upon the Society. Election to patronship carries with it the rights and privileges of *fellows*.

## BY-LAWS

### *Article I. Membership*

*Section 1. Eligibility.* Any person who has, in the opinion of the Council, contributed materially to the advancement of mineralogy, crystallography, or allied sciences, shall be eligible for fellowship in the Society. Any person or corporation interested in mineralogy, crystallography, or allied sciences shall be eligible to membership.

*Section 2. Election.* (a) *Fellows.* Nominations for fellowship must be made by two fellows according to a form to be provided by the Council. One of these fellows must be personally acquainted with the nominee and his qualifications. The Council will submit the nominations received by them, if approved, to a vote of the fellows in the manner provided in the By-Laws. The result may be announced at any stated meeting, after which notice shall be sent to the elected. (b) *Members.* Nominations for membership must be made on blanks provided by the Council, and receive the endorsement of the secretary and treasurer of the Society.

*Section 3. Termination.* Membership in the Society may be terminated or the names of the members may be placed upon the inactive list by vote of the Council.

### *Article II. Dues*

*Section 1.* No person shall be accepted as a fellow of the Mineralogical Society of America unless he pays dues for the year within three months after notification of his election. The annual dues for fellows shall be five dollars (\$5), payable at or before the annual meeting in advance.

*Section 2.* The annual dues for members shall be three dollars (\$3). No person shall be accepted as a member unless he pays the dues for the year within three months after notification of his election. The annual dues shall be payable at or before the annual meeting in advance.

*Section 3.* An arrearage in payment of annual dues of four months shall deprive a fellow or member of the privilege of taking part in the management of the Society and of receiving the publications of the Society. An arrearage continuing over two (2) years shall be construed as notification of withdrawal.

*Section 4.* A single prepayment of one hundred dollars (\$100) shall be accepted as commutation for life for either fellows or members. In the case of fellows who are also fellows of the Geological Society of America, a single prepayment of fifty dollars (\$50) shall be accepted as commutation for life.

*Section 5.* Any person eligible under Article IV of the Constitution may be elected patron upon the payment of one thousand dollars (\$1000) to the Society.

### *Article III. Duties of Officers*

*Section 1. Officers.* The duties of the president, vice-president, treasurer, secretary, and editor of the Society shall be the usual ones performed by such officers.

*Section 2. Executive Council.* The Executive Council shall direct all affairs and activities of the Society not otherwise provided for by the Constitution, as well as perform those duties specifically assigned to it.

*Section 3. Committees.* The president shall appoint, with the approval of the Council such committees as may further the objects of the Society, including a board of associate editors. The treasurer, the secretary, the editor, and the chairmen of the various committees shall make formal reports to the Society at least once a year.

#### *Article IV. Election of Officers and Fellows*

*Section 1.* Nominations for office shall be made by the Council. The list shall be published in the Journal of the Society at least three months before the annual meeting. Any ten (10) fellows or members may forward to the secretary other nominations for any or all offices. All such nominations reaching the secretary not later than November 1 shall be printed, together with the names of the nominators, as special ballots. The regular and special ballots shall then be mailed to the general membership. The results shall be announced at the annual meeting, and the officers thus elected shall enter upon duty at the adjournment of the meeting.

*Section 2.* The list of nominations for fellowship in the Society shall be sent to the fellows at the same time as the nominations for officers. Five opposing votes shall be considered as rendering a candidate ineligible for fellowship.

#### *Article V. Publications*

The Society shall publish a journal devoted to the advancement of mineralogy, crystallography, and allied sciences. The general membership of the Society shall be entitled to receive the journal.

#### *Article VI. Affiliation with Other Scientific Organizations*

The Council shall have the authority to arrange for affiliation with other scientific organizations, and, as the occasion may arise, to appoint fellows to represent the Society on the Councils of such organizations. In the case of the Geological Society of America, the representative so appointed shall also be a fellow of the Geological Society of America, and shall be recommended to the Council of said society for confirmation as one of its nominees for the vice presidency.

#### *Article VII. Local Sections*

Local sections of the Society may be formed in any locality, with the advice and consent of the Council, for the purpose of holding meetings and promoting cooperation. The affairs of such local sections shall be entirely in their own hands.

#### *Article VIII. Meetings*

There shall be an annual meeting of the Society and such other meetings as may be called by the Council. The annual meeting shall be held, whenever practicable, at the same time and place as that of the Geological Society of America.

#### *Article IX. Revision of the By-Laws*

After recommendation by the Council, by-laws may be enacted, amended, or suspended by a two-thirds vote, by ballot, of the general membership of the Society.

## CHANGES IN THE BY-LAWS

*Article I. Membership*

*Section 1.* . . . Any person or corporation interested in mineralogy, crystallography, petrography, or allied sciences, shall be eligible to membership.

*Section 2. Election.* (a) Fellows . . .

(b) Members. *Candidates for membership in the Mineralogical Society of America should be endorsed by at least one fellow of the society and the application approved by either the secretary or treasurer acting for the Council.*

*Article II. Dues*

*Section 1.* . . . *The annual dues for fellows of the Mineralogical Society of America who also pay dues as fellows of the Geological Society of America shall be two dollars (\$2), payable at or before the annual meeting in advance. This provision shall continue in effect as long as the Geological Society of America shall contribute funds which the Council of the Mineralogical Society of America shall consider adequate to assist in publication of the Journal of the Mineralogical Society of America.*

*Article V. Publications.*

The Society shall publish a journal devoted to the advancement of mineralogy, crystallography, petrography, and allied sciences.

## BOOK REVIEWS

CRYSTAL CHEMISTRY by CHARLES W. STILLWELL. vii+424 pp., 127 Tables, 72 Figures and a chart. McGraw-Hill Book Company, New York, 1938. Price \$4.50.

This book is primarily intended for students of chemistry but it contains so much of interest to mineralogists and crystallographers that it seems proper to bring it to the attention of the readers of this journal.

Though lacking the balance and charm of Evans' "An introduction to crystal chemistry," recently reviewed here (vol. 24, p. 657), it has many good points. Its scope is indicated by the statement in the preface that "Crystal chemistry is the study of (1) the laws governing the arrangement of atoms in solids and (2) the influence of the arrangement and the electronic structure of the atoms upon the physical and chemical properties of the solid." Data illustrating both of these points are well summarized in numerous tables which form a very attractive feature of the book.

Since students interested mostly in the results may get their notions of the methods of crystal structure determination from this book, it is unfortunate that it propagates the false idea that structures may be determined by measurements of interplanar spacings, witness the following quotation from the first chapter: "When the distances between many sets of intersecting planes have been calculated, the position of each atom in the crystal becomes known."

A. PABST



SPECTROCHIMICA ACTA, ein Forschungsarchiv. Published by Julius Springer, Berlin. Vol. I, No. 1, May 1939, 92 pages, R.M. 8.60.

This new journal is the first devoted to the field of spectrochemical analysis. The method of qualitative and quantitative analysis by the spectrograph is based on the discovery, in 1860, by Kirchhoff, that each atom emits a characteristic spectrum by which its presence may be recognized. For many years this principle found little practical application, but recent developments in spectroscopic light sources and in photographic photometry have enabled spectrochemical analysis to compete with or to replace ordinary chemical methods in an increasing variety of applications.

This development has resulted in a large increase in the literature devoted to the subject. Meggers and Scribner in their Index to Literature in Spectrochemical Analysis (Am. Soc. for Testing Materials, Phila. 1939), list an average of 10.5 papers a year in the years 1920-25; for the years 1932-37 the output of papers on the subject had grown to an average of 107 papers a year. Examination of this index shows that the papers are scattered through a wide range of biological, chemical, physical, mineralogical, and metallurgical journals. Since few libraries receive all these journals and no single abstract journal covers all this literature, the individual worker can hardly be expected to find it all. In a new and growing field where methods are rapidly changing and procedures being improved, and where no general technique has been established, there seems to be a need for a journal of international scope to publish articles covering the applications of spectroscopy in different branches of sciences, and to provide reviews and abstracts covering the entire field.

Spectrochimica Acta is intended to meet this need. The Editorial Board consists of Professor R. Breckpot of the University of Louvain, Belgium; Dr. A. Gatterer of the Vatican Observatory, Italy; Professors W. Gerlach and G. Scheibe of Munich, Germany; and Mr. F. Twyman, Managing Director of Adam Hilger, London, England, France, Germany, Italy and the United States. The Editorial Board is made up of leaders in spectrochemical analysis and covers the countries in which most of the recent work has been done, with the exception of Japan and the U. S. S. R., in both of which there has been considerable recent activity.

The first number includes, besides book reviews and abstracts in English and German, articles in English by J. A. C. McClelland and H. K. Whalley on "The Quantitative Spectrochemical Analysis of Solder, Spelter, Magnesium and Aluminum Alloys"; and in German by H. Kaiser on observations on "Changes in Sparking Conditions during Analysis of Aluminum Alloys"; by A. Gatterer and J. Junkes on "The Quantitative Determination of Very Small Amounts of Europium in Samarium"; by G. Scheibe and J. Martin on "A New Application of Emission Spectroscopy to local Micro-analysis"; and by R. Rollwagen on "Physical Phenomena of Arc Discharges and their Significance for Spectro-analytical Investigations." These first articles set a high standard. It is to be hoped, however, that succeeding issues will discuss applications of spectrochemical analysis to other than metallurgical problems.

Spectrochimica Acta is to appear at irregular intervals as articles accumulate. Present conditions in Europe will doubtless hamper the production and circulation of the journal. The journal seems to fill a real need and it is to be hoped that it will not be a victim of war conditions or of its rather high price.

RALPH A. SAWYER, *Univ. of Michigan*

## PROCEEDINGS OF SOCIETIES

### PHILADELPHIA MINERALOGICAL SOCIETY

#### *Philadelphia Academy of Natural Sciences*

A stated meeting of the Philadelphia Mineralogical Society was called to order on September 7 by Pres. Harry W. Trudell, with 42 members and 23 visitors in attendance.

Mr. James G. Manchester addressed the society on the collecting of chalcedony pseudomorphs after coral from Ballast Point, Tampa Bay, Florida. The corals are found in place at very low tides. Silicification is still in operation and all stages of the process can be observed. The chalcedony has replaced the outer surfaces of the corals, and in most cases the inside material has been dissolved, resulting in geodes with mamillary interiors. The speaker illustrated the report with a series of lantern slides.

The latter part of the evening was devoted to reports of summer trips. Mr. Poole described the events of the Mineral Day program of the New York World's Fair. Those giving reports and exhibiting material collected during the summer included Messrs. Whitson, Johle, Morgan, Meier, and Moyd.

A meeting of the Philadelphia Mineralogical Society was called to order on October 7, 1939 by Pres. Harry W. Trudell, with 45 members and 25 visitors attending.

Election of officers for the 1939-40 season was held with the following results:

President:	Dr. W. Hersey Thomas
Vice-President:	Dr. J. F. T. Berliner
Secretary:	Mr. Louis Moyd
Treasurer:	Mr. Wiley Flack
Councillor:	Mr. Harold Arndt

The subject of the evening was *Reports of Summer Excursions*. Mr. Arndt revisited a number of localities in New England and described them as they were twenty years ago and at present. Mr. Jehle collected vivianite at Mullica Hill, N. J., and discussed the flaking of flint implements. Mr. W. Leigh Smith, with Mr. Tomlinson, visited Perkiomenville, Blue Ball, Quarryville, Avondale, Downingtown, and Barto, Pa., and Cockeysville, Md. Mr. Trudell reported on a trip taken with the Messrs. Gordon and Knabe to the Adirondacks. Mr. Evans visited gold and copper mines at Libertytown, Morristown, and Pabscot, Va., the Morefield Mine at Amelia, and the mines near Spruce Pine, N. C. Mr. Allbrecht visited Ellenville, Herkimer, Gore Mt., and Tilly Foster Mine in N. Y., the Black Lake area and Gaspe, Quebec, Newry, Me., Grafton, N. H., Westfield Mass., and Portland Conn.

Mr. Gordon reported on his trip in the west. He visited Pikes Peak, Denver, Col., Pioche and Owens Valley, Nev., and Mono Crater.

Mr. Frorer visited Thetford, Quebec. Dr. Gillson reported on the field trip of the Society of Economic Geologists, which visited various districts in California, the Comstock Mine and Lassen Peak. Dr. Thomas obtained anthraxolite at Cataqui, Ont., and visited Indian Pond, Madoc, Deloro, Millbridge, Bancroft, Hybla, and the Phoenix Molybdenite Mine, West of Renfrew, Ont. Many interesting and beautiful specimens were exhibited by the speakers.

President W. Hersey Thomas called to order a meeting of the Philadelphia Mineralogical Society on November 2, 1939, with 50 members and 22 visitors in attendance.

Mr. Martin L. Ehrmann spoke to the Society on his trip to Mexican mineral localities during the past summer with Dr. William F. Foshag of the U. S. National Museum.

They collected scorodite, hemimorphite, and fluorite at Mapimie, Mexico's largest lead producer. At Durango, they obtained fine gemmy apatite crystals and martite from Iron Mountain. At Sombriete, they saw a considerable quantity of proustite in place in an old mine. The speaker said that the well known apophyllite-amethyst groups and associated minerals really come from La Luz, a short distance away from Guanajuato. They stopped at Pachuca which, at present, produces 20 per cent of the world's silver. At Cordero, the famous Mexican opals are obtained from a rhyolite ridge 30 miles long. Mr. Ehrmann illustrated his address with good specimens, lantern slides, and motion pictures.

LOUIS MOYD, *secretary*

#### NEW YORK MINERALOGICAL CLUB, INC.

*American Museum of Natural History, November 15, 1939*

The meeting was called to order by President Lee with 71 members and guests present. Mr. Northrup, Acting Chairman of the Excursion Committee, reported on the Election Day trip to Vandermade's and Braen's trap rock quarries. The outstanding finds of the day were greenockite in yellow coatings and fine crystals of babingtonite. About 40 members attended.

The President then introduced the speaker of the evening, Mr. Martin L. Ehrmann, who told of his experiences collecting minerals in Mexico. He was accompanied by Dr. William F. Foshag, of the U. S. National Museum. The first stop was made at Hot Springs, Arkansas.

The first stop in Mexico was at the Ojuela Lead Mine in the State of Durango. This mine produced at one time one-third of the world's supply, but is now operated under a sub-lease on a much reduced scale. Large white hemimorphite crystals and half-inch transparent green scorodite crystals were found at this locality, as well as good carminite.

The next visit was to the hematite mine at Cerro Mercado, a locality long famous for its golden apatite crystals. Rich ore with a high iron content is mined here by very primitive quarrying methods. The apatite crystals found occurred in fissures in a matrix of semi-opal, chalcedony and sepiolite.

The Sombriete silver mine which formerly produced fine specimens was not working and nothing was obtained. This was also true of La Luz and other mines of the Guanajuato district, the Queretaro opal mines and the Pachuca silver mine. However, good specimens of mimetite and fair scorodite were obtained at a silver mine at Taxco, 100 miles south of Mexico City. This mine, reported to be the largest silver mine in the world, has been in operation since 1524.

F. H. POUGH, *Secretary*



## NEW MINERAL NAMES

### Tchinglusuite (Chinglusuite)

V. I. GERASMOVSKY: Tchinglusuite, a new mineral. *Bull. Acad. Sci. U.S.S.R., Cl. Sci. Math. Nat., Ser. Geol.*, 153-157 (1938). (Russian, English summary, latter contains several errors.)

NAME: From the locality, Chinglusuai River, Kola, U.S.S.R.

CHEMICAL PROPERTIES: A complex hydrous titano-silicate of sodium and manganese,  $2(\text{Na}, \text{K})_2\text{O} \cdot 5(\text{Mn}, \text{Ca})\text{O} \cdot 3(\text{Ti}, \text{Zr})\text{O}_2 \cdot 14\text{SiO}_2 \cdot 9\text{H}_2\text{O}$ . Analysis:  $\text{SiO}_2$  39.50,  $\text{TiO}_2$  9.62,  $\text{ZrO}_2$  3.02, rare earths 1.18,  $\text{ThO}_2$  0.06,  $\text{Al}_2\text{O}_3$  n.d.,  $\text{Fe}_2\text{O}_3$  2.84,  $\text{FeO}$ , n.d.,  $\text{CaO}$  1.75,  $\text{SrO}$  none,  $\text{MnO}$  14.53,  $\text{MgO}$  none,  $\text{Na}_2\text{O}$  5.52,  $\text{K}_2\text{O}$  0.41,  $\text{H}_2\text{O}(+110^\circ)$ , 7.92  $\text{H}_2\text{O}(-110^\circ)$ , 13.92,  $\text{Cl}$ , 0.12,  $\text{F}$  none,  $\text{P}$  trace. Sum 100.39, less  $\text{O} = \text{Cl}, \text{F}$  0.02, Total = 100.37 per cent. Does not gelatinize with acids. In conc.  $\text{HCl}$  decomposes easily without warming. In conc.  $\text{HNO}_3$  decomposes on warming. In conc.  $\text{H}_2\text{SO}_4$  decomposes slowly upon heating. Spectrographic examination shows the rare earths to be chiefly Yb, Y, Ho.

PHYSICAL AND OPTICAL PROPERTIES: Grains about 0.5 cm. in diameter, crystals not observed. Color black. Streak brownish. Luster resinous. Cleavage lacking. Fracture uneven. Opaque. Hardness 2-3. Gravity by pycnometer 2.151 on a sample of 3.2518 g. In closed tube swells and easily melts to a dark-brown glass, almost black in color. With borax in oxidizing flame gives a bead of rather pale violet-rose color (both hot and cold), which fades in the reducing flame. Salt of phosphorus bead is pale yellowish-green in both oxidizing and reducing flames, the color disappearing on cooling.

In thin section pale yellow, in powder yellow-brown to black. Isotropic. Index of refraction 1.582. X-ray studies show the mineral to be amorphous, hence in the metamict state, probably due to the content of radioactive matter.

OCCURRENCE: Found in pegmatites in the Chinglusuai River valley, Lovozero Tundra, Kola, U.S.S.R., with hackmannite, eudyalite, lamprophyrite, ramsayite, etc. Exact locality uncertain, as it apparently was found only in blocks of sodalite-syenite pegmatite in the stream debris.

J. P. MARBLE

### Magnophorite

REX T. PRIDER: Some minerals from the leucite-rich rocks of the West Kimberley area, Western Australia. *Mineral Mag.*, 25, No. 166, 373-379 (1939).

NAME: Magnophorite, from its relationship to katophorite; a kali-magnesio-katophorite.

CHEMICAL PROPERTIES: A member of the amphibole group;  $(\text{Ca}, \text{Na}, \text{K})_{3.15}(\text{Mg}, \text{Fe}, \text{Ti}, \text{Mn})_{5.22}(\text{Si}, \text{Al}, \text{Ti})_{8.00}\text{O}_{22}(\text{OH}, \text{F})_{1.04}$ . Analysis:  $\text{SiO}_2$  52.67,  $\text{Al}_2\text{O}_3$  1.72,  $\text{TiO}_2$  3.53,  $\text{Fe}_2\text{O}_3$  0.58,  $\text{FeO}$  2.41,  $\text{MnO}$  0.06,  $\text{MgO}$  21.32,  $\text{CaO}$  6.95,  $\text{SrO}$  0.15,  $\text{Na}_2\text{O}$  3.64,  $\text{K}_2\text{O}$  5.70,  $\text{H}_2\text{O} + 0.46$ ,  $\text{F}$  1.29; Sum 100.48, less  $\text{O} = \text{F}$  0.54; Total 99.94.

PHYSICAL AND OPTICAL PROPERTIES: Color pale reddish brown. Pleochroism,  $\alpha$  = colorless to pale yellow,  $\beta$  = reddish,  $\gamma$  = pale to bright yellow, occasionally slightly greenish. Absorption  $\beta > \gamma > \alpha$ .  $G = 3.12$ .

Biaxial,  $2V = 70^\circ$ . Dispersion rather strong  $r < v$ . Optic plane (010).  $\alpha = 1.616$ ,  $\gamma = 1.632$ ,  $\gamma - \alpha = 0.016$ .



OCCURRENCE: As an abundant essential constituent of the leucite lamproites (made up of diopside, phlogopite, magnophorite and leucite) from West Kimberley, Western Australia. A similar amphibole is found in the jumillites of Murcia, Spain, and the orendites of the Leucite Hills, Wyoming.

W. F. FOSHAG

### Wadeite

REX T. PRIDER: Some minerals from the leucite-rich rocks of the West Kimberley Western Australia. *Mineral Mag.*, 25, No. 166, 379-382 (1939).

NAME: In honor of Dr. Arthur Wade, who collected the material.

CHEMICAL PROPERTIES: A silicate of potassium, calcium, zirconium, related to catapleiite. Formula: essentially  $K_2CaZrSi_4O_{12}$ . Analysis  $SiO_2$  39.43,  $P_2O_5$  3.15,  $Al_2O_3$  5.98,  $Fe_2O_3$  trace,  $TiO_2$  1.63,  $MgO$  0.28,  $ZrO_2$  21.29,  $CaO$  5.22,  $SrO$  0.16,  $Na_2O$  2.82,  $K_2O$  18.40,  $BaO$  1.20,  $H_2O+1.30$ ; sum 100.86. Insoluble in hot acids.

CRYSTALLOGRAPHICAL PROPERTIES: Hexagonal. Habit, hexagonal shaped basal sections.

PHYSICAL AND OPTICAL PROPERTIES: Colorless.  $G=3.10$ . Cleavage pyramidal, poor. Uniaxial, positive.  $\epsilon=1.655$ ,  $\omega=1.625$ ,  $\epsilon-\omega=0.030$ .

OCCURRENCE: Found at the Wolgidee Hills, associated with magnophorite (*vide supra*) and making up 1 or 2 per cent of the rock.

W. F. F.

### Magnesiumapjohnite Manganpickeringite Eisenpickeringite Magnesiumhalotrichite

HEINZ MEIXNER, AND WOLF PILLEWIZER: "Über Minerale, die teils im Schrifttum, teils in Sammlungen als 'Keramohalit' bezeichnet werden (Bosjemanit von Terlan in Südtirol, Eisenpickeringit von Dienten, Pickeringit von Mitterberg in Salzburg und einige Halotrichitvorkommen)." *Zentr. Mineral., Abt. A.*, 263-270 (1937).

Intermediate members of halotrichite group.

W. F. F.

The Division of Geological Sciences of Harvard University, together with many friends and former students, tendered a dinner to Professor Charles Palache upon his retirement as Professor of Mineralogy and Curator of the Mineralogical Museum on Monday, February 5, 1940. After the dinner a portrait of the Professor was presented to the University in the Mineralogical Museum.

Professor Palache has served Harvard University for forty-five years and in these years the Department of Mineralogy and the Mineralogical Museum have grown into great prominence.

### TEACHING FELLOWSHIP IN MINERALOGY

A teaching fellowship in mineralogy has been established at Stanford University. The fellowship is open to graduate students who intend to specialize in mineralogy, and preference will be given to those who have had one or two years of graduate work. The chief work duty of the fellow is to assist in laboratory instruction. Not more than eight or nine hours a week will be required. The amount of the fellowship is \$750.

Application for the year 1940-41, supported by testimonial letters should be made to Professor Austin F. Rogers, Box 87, Stanford University, California.